POWER

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Is Your Boiler Insurance a Gamble?

German Manufacturing Power Plant

SYNOPSIS—A German manufacturing power plant in which there are two 100-kw., bleeder-type steam turbines, steam being taken from the second stage for heating purposes. The two 3-flue return boilers are mechanically fired. Coal is delivered in cars and the load discharged into a coal pocket by upending the car on a car tipper.

The development of the Wanderer-Werke Actien Gesellschaft, at Schonau, near Chemnitz, Germany, is an example of present-day industrial growth. In 1885, John Baptist Winklhofer and Richard Jaenicke organized a company for the sale of bicycles, and at first employed two men; today more than 3000 are employed in the manufacture of bicycles, automobiles, typewriters, etc.

The factory is lighted by 200 to 600-cp. metallic-filament lamps on the semidirect system. About 140 lamps are on each floor. Heat is obtained for the factory by using exhaust steam through coils, which comes from the turbine in the power plant at about 37 lb. pressure. The machine tools in the factory are either driven by separate motors or in groups. Before the erection of the new power plant, electrical energy was supplied, for the greater part, by the municipal electric works, but the repeated stoppage or curtailments of the supply during the winter months compelled the building of a private power plant, which has been designed with a view to future extensions. When work was started, the total current consumption in the factory was about 600 kw. for power and 350 kw. for lighting purposes.

Turbine Room

The turbine room has floor space for four steam turbo-generators of 1000-kw. capcity each, at 3000 r.p.m. Two have been erected, Fig. 1. Both turbines are arranged for drawing off steam from the second stage of the turbine for heating purposes. The generators are three-phase, 50-cycle, and supply current at 525 volts.

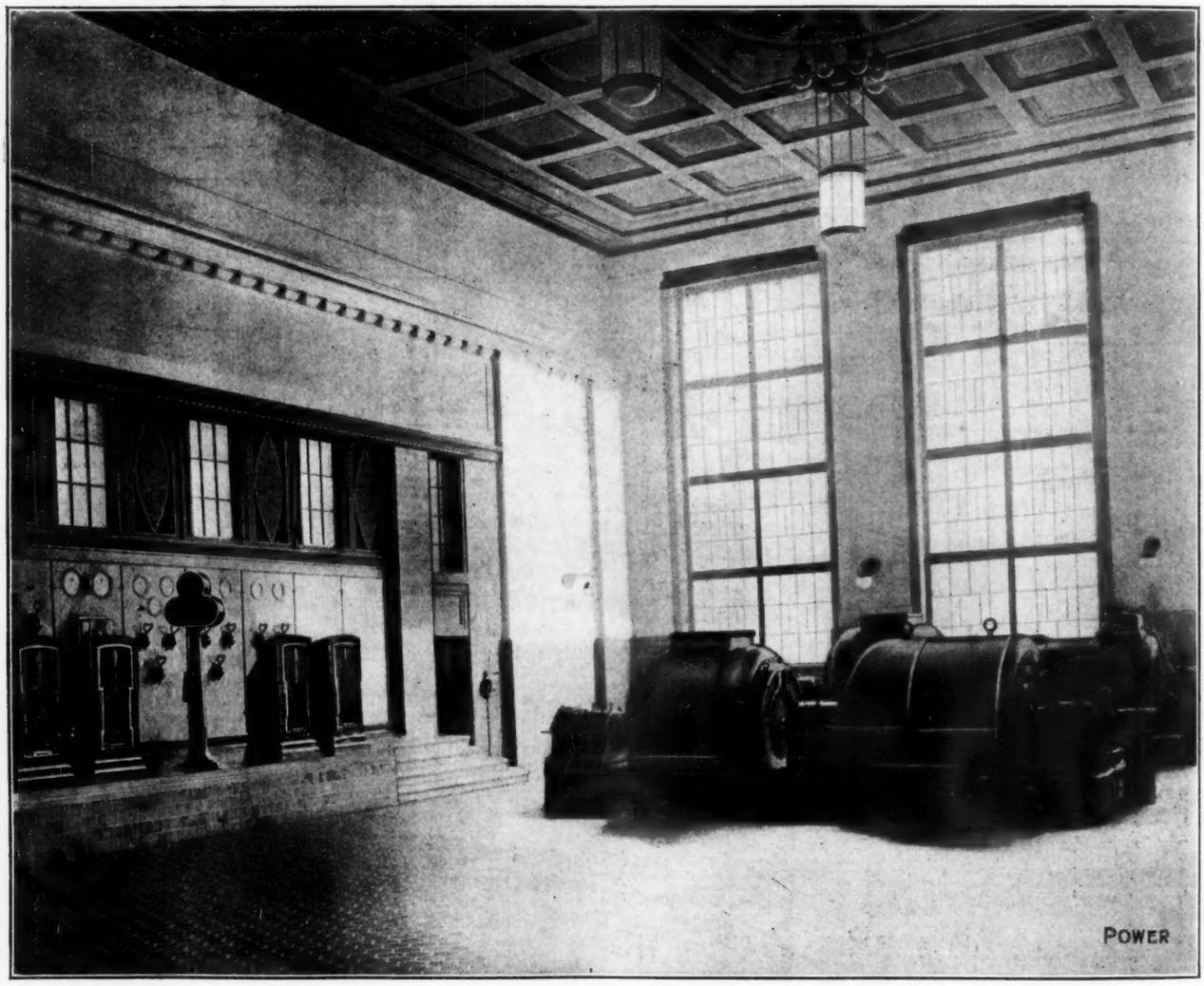


Fig. 1. Partial View of the Turbine Room

As the available water for condensing purposes is limited, a cooling tower is used capable of handling 1321 gal. of water per hour. Motor-operated oil switches are used, and the current for power purposes is supplied by cables to the distribution boards of the various depart-

ments at about 500 volts. The current for lighting purposes is transformed down to 290 volts and used as monophase current with a neutral conductor, carrying 110 volts. Although the factory has its own power plant, connections have been made with the local supply so that in emergency, power can be obtained from outside. Although one turbo-generator is kept as a spare unit, the wiring is arranged so that at night, when work is stopped, well pumps and the emergency lighting can be carried by current supplied by the outside company. The emergency lighting system is automatically switched on the municipal circuit if for any reason the current generated by the power plant should fail.

Boiler House

The boiler house is designed for four boilers, Fig. 2, and contains at present two 3-flue tubular boilers in one battery with double steam drums, each boiler having a heating surface of 6479 sq.ft. and working at a maximum pressure of 220 lb. The boilers are equipped with built-in superheaters having a capacity of 16,534 lb. of steam per hour. Furnace gases are carried off by a chimney 236 ft. high and 8.85 ft. inside diameter. The temperature of the gases is 350 deg. C. The boilers are equipped with stokers and water is automatically fed by a duplex steam pump. An auxiliary feed arrangement consists of a motor-driven seven-stage centrifugal pump. The feed water tanks for cold and condensing water are located in a chamber above the pump, so that the water can flow to the pump with a head. The pumps are also connected with the pipe system of the fire hydrant so that in case of fire, water at about 120 lb. pressure is available at any point in the factory. Water for heating purposes, etc., is obtained from a deep well.

Coal is delivered on a railway siding and the cars are run over a weigh bridge and turntable to the boiler house, where the load is dumped into a concrete coal hopper by means of a car tipper, Fig. 3.

A coal conveyor discharges the coal into bunkers above the boiler furnaces, which hold 11 double truck loads each. From these the coal passes automatically into the stoker hoppers.

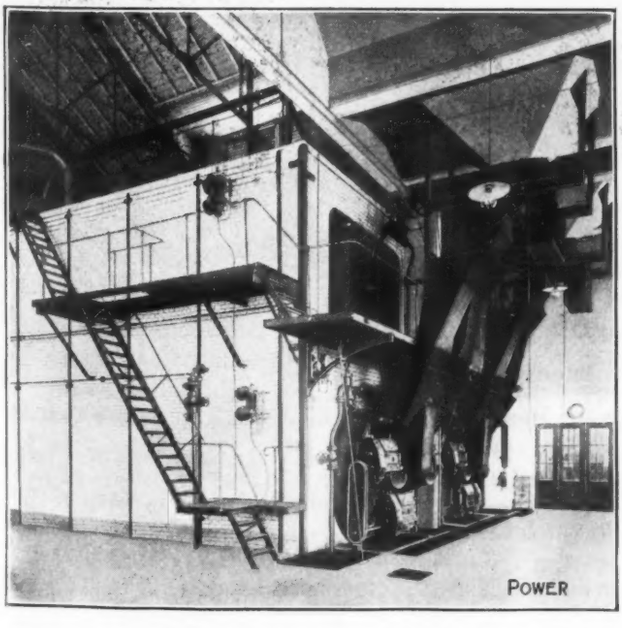


Fig. 2. Boiler Room and Two Three-Flue Boilers

Fig. 3. Discharging a Carload of Coal to the Boiler-House Conveyor

Ashes and clinkers are passed into an ashpit arranged in front of the boilers below the furnaces, and are conveyed from there by cinder cars and hoists to an elevated bunker, from which trucks and railway cars are loaded direct.

The boiler and engine-room floors and ceilings are faced with tile. The engine room is fitted with colored glass windows, paneled ceiling and a lighting installation consisting of 33 metallic-filament lamps of 100 cp. each.

First Aid in Ammonia Accidents

The National Ammonia Co., New York, is distributing large cards giving directions for treating persons suffering from ammonia accidents. These directions, given below, should be of interest to all engineers handling ammonia refrigeration plants:

First summon a doctor, prompt action being of great importance, and until his arrival apply the following remedies:

EXTERNAL

For the eyes: First, pour a 1 per cent. solution of pure boric acid into the eyes, instructing the patient to open and close the lids rapidly to bring the solution in contact with the entire inner surface. Use freely, as the solution is not dangerous.

Second, after thoroughly washing the eyes, place a small quantity of clean, plain vaseline under the lids by pulling down the lower lid and applying the vaseline with a match-shaped piece of wood having smooth, rounded ends.

For the skin: Apply lint or linen or washed muslin dripping wet with carron oil, changing the dressing frequently. (By keeping lime water and linseed oil separately, a fresh solution of carron oil may be prepared each time by mixing thoroughly equal parts of the two ingredients.)

INTERNAL

For nose and throat if inhaled: Dip a handkerchief or a piece of gauze folded once in vinegar, wring it out lightly and lay it loosely over the nose and mouth. (If liquid ammonia has entered the nose, snuff up some diluted vinegar and apply sweet oil with a feather to the inner surface of the nostrils.)

If ammonia has been swallowed: Administer diluted vinegar or have the patient suck orange or lemon juice in lib-

eral quantities and follow with one to four teaspoonfuls of sweet oil, milk, or the whites of three or four eggs and some ice. (If vomiting occurs, aid it by giving liberal draughts of lukewarm water.)

GENERAL INFORMATION

Ammonia gas is lighter than air and, being released, rises. Therefore, in case of accident, keep your head as low as possible.

On going to the rescue of one overcome by ammonia gas keep near the floor and place a wet sponge or cloth over the mouth and nostrils. Water will absorb the gas and prevent its inhalation.

Keep the following supplies on hand in a clean and easily accessible cabinet:

A 1 per cent. solution of pure boric acid, one bottle of clean, plain vaseline, one package of surgeon's lint or muslin, a package of plain gauze, one pint of best quality vinegar, one pint of sweet oil, and one pint of carron oil (linseed oil and lime water, equal parts).

Interesting Air-Compressor Record

By Frank Richards

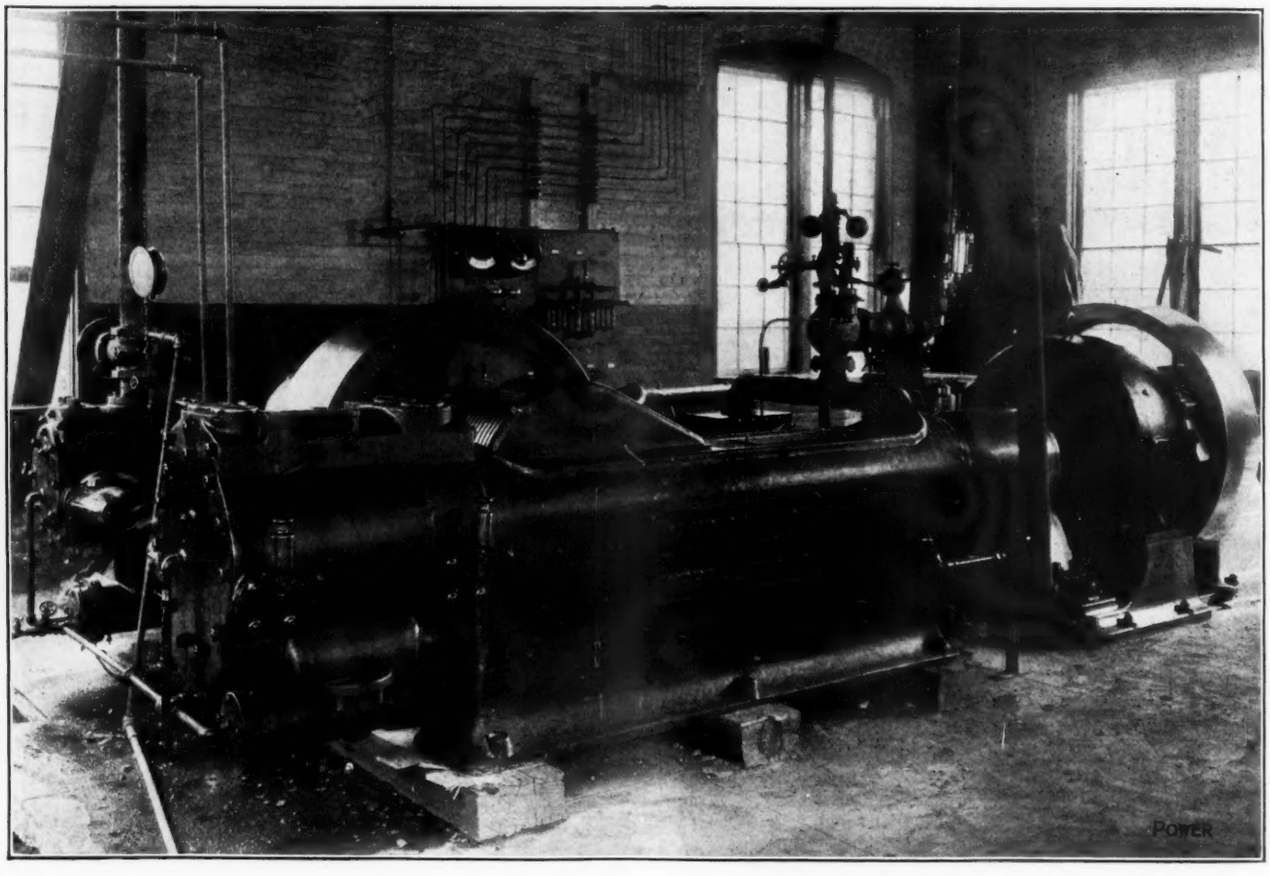
The accompanying illustration shows an air compressor at the Hollenbeck colliery of the Lehigh & Wilkes-Barre Coal Co. The machine is self-contained, with high-pressure steam cylinders and two-stage air cylinders, the diameter of the former being 12 in. and the latter 18 in. and 11 in., with a common stroke of 16 in.; the theoretical free-air capacity at 150 r.p.m. being 704 cu.ft. per min.

This compressor was shipped on June 27, 1905, and was immediately set up and put to work. Since then it has been operated continuously 24 hours per day with the exception of a regular stoppage of two hours on Sunday for inspecting the discharge valves and a general cleaning up and looking over. For three or four years past the machine has been too small for the work and has been run at a speed of from 170 to 225 r.p.m.—600 ft. piston speed.

The engineer of the power house states that the cylinders have not been rebored, and that the compressor is still fitted with the same pistons and piston rings, as when shipped from the factory. The discharge valves and discharge-valve springs have been renewed, some of them having been in service for five or six years. There has never been any delay at this colliery that could be attributed to the compressor.

This machine has recently been replaced by a compressor of much larger capacity. When the change was made it was picked off its foundations and placed on the power-house floor upon three 12x6-in. timbers as shown, without bolts or fastening of any kind, the pipe connections were made, and the compressor was started up and is still running at its highest speed.

The illustration shows the compressor running, as is indicated by the disappearance of the flywheel arms, but the governor is not running, as the driving chain is not in place. The sharpness of detail shows the absence of jar or vibration.



Compressor Operating at Full Speed without Foundation or Anchor Bolts

The machine has had the best of care and systematic inspection. The oil, for instance, has been taken out of the crank cases and filtered every three weeks and make-up oil added. Beyond this care, the engineers have exercised the happy faculty, sometimes painfully lacking, of letting well enough alone and giving things a fair chance. For the information here presented the author is indebted to William Wilhelm, of Philadelphia.

Electrically Operated Steam-Pressure Regulator

By Ernest Giles

The regulator described herewith has been in constant use 24 hr. a day, six days a week, for over four years in the news-paper mills of the Finch-Pruyn Co., Inc., Glens Falls, N. Y., on its largest machine, and has proved so satisfactory that another machine is to be equipped with a similar regulator.

The machines, previous to the installation of the electric regulator, were each equipped with a hydraulic regulator, which gave fair satisfaction, but would go out of commission every time the water pressure was turned off, therefore, as the electric service was dependable, an electric regulator was desirable.

In paper-mill practice, the engine driving the machine exhausts into the machine dryers and furnishes

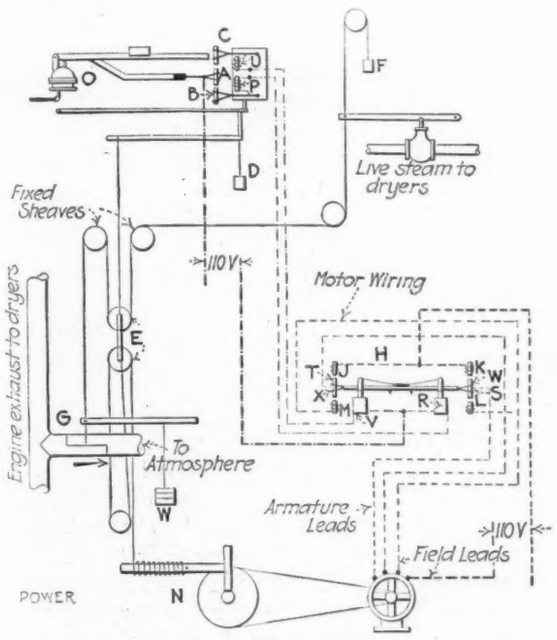


Fig. 1. Arrangement of the Exhaust and Live-Steam-Valve Control

most, if not all, of the steam heat used. Under some conditions live steam is necessary to help out.

Fig. 1 shows the arrangement of the exhaust- and live-steam valves, also the manner of connecting them jointly with a cable, so that no live steam will be used unless the exhaust from the engine should be insufficient. The exhaust valve is held closed by a heavy weight attached to the valve lever, to which one end of the cable is attached and then passed over a fixed and a movable sheave with an up-and-down travel; then over two more fixed sheaves connecting to the live-steam valve lever. This valve is free to open with the pressure as the cable becomes slack by an upward travel of the movable sheaves, the exhaust valve remaining closed. A downward travel of the movable sheaves will first close the live-steam valve and then open the exhaust valve. The exhaust cannot be opened until the live-steam valve is closed, as the weight *W* on the exhaust is sufficient to hold the live steam closed.

The illustration shows the arrangement of the diaphragm weight lever, which adjusts the pressure to the amount required; this lever also carries the contact *A*, which has an up-and-down movement with the lever.

Below and above the contact *A* are *B* and *C*, which are moved up and down by the travel of the movable sheaves, connected in the valve-operating cable, and serve to compensate the regulator. These contacts are mounted on the ends of armatures, which also have a slight up-and-down movement, being operated by small electro-magnets, one just below the upper and one just above the lower contact. Any current passing through them must also pass through the small electro-magnets, thus drawing the contacts *B* or *C* to a closer connection with *A*. This is necessary, otherwise the contact would be poor and unsatisfactory, due to the light pressure exerted by *A* in closing against *B* or *C*.

The contact *A* will always have a slight movement up and down, due to the engine exhaust (the regulator diaphragm is connected to the dryers to which the engine exhausts), which would aggravate the poor contact of *A*. This fault is overcome by the arrangement shown.

The weight *D* hanging from the compensating arrangement prevents all lost motion and lowers the contacts *B* and *C* when the movable sheaves *E* travel upward. The weight *F* is to hold the cord tight, thereby keeping it on the sheaves when moving the regulator by hand and the steam is off; also, while inspecting the apparatus when the paper machine is not running.

Excessive pressure in the dryers will blow the exhaust valve *G* open, the weights being proportioned to admit of such action.

The relay *H* is an electrically operated reversing switch, and serves to start the motor in either direction and to open the motor circuit at the proper time. It is controlled by the contact *A*. There are two solenoids, one on either end of a lever and connected to it through their plungers by flat flexible springs, as shown. The lever rests on two knife edges indicated by the two small arrows and so placed that when no current is flowing through either coil the lever stands in the position shown, with the motor circuit open in two places.

Relay contacts *J* and *K* are hinged and make just before *L* or *M*, which is necessary to allow for any slight wear of the ½-in. contact carbons.

The cable control *N* consists of a shaft carrying a light wooden pulley belted to the motor and a worm which meshes with a wheel on another shaft carrying a drum upon which the free end of the lower controlling cable is wound or unwound. It is driven by a small series wound fan motor.

The operation of the system is as follows: Consider that the steam pressure under the diaphragm *O* has been holding the weighted arm in the position shown, but for some reason it drops a little; the balance arm will then lower, carrying with it the contact *A* until it makes contact with *B*. The path of the current will be through *A* to *B* and then through the magnet *P*, which will instantly hold *B* in contact with *A*. From *P* the current

will flow through the relay coil R, closing the relay contacts S and T against L and J.

With this position of relay contacts there is a path through the motor fields to the contacts L and S to the left-hand armature lead, through the motor armature, and then to the contacts T and J and to the line. This will start the motor in the direction to unwind some of the cable wound on the drum N which allows the movable sheaves E to rise. The slack in the cable connecting the valves will be taken up by the live-steam valve, which will open a little.

At the time that the sheaves E move upward the contact B will be lowered, breaking contact with A, which allows the relay to assume its normal position and shut off the current to the motor, thus stopping any further movement of the valves. If this movement is not enough to check the lowering of the pressure under the diaphragm, the cycle of operation will be repeated until the arm again assumes a balanced position.

Considering that the pressure rises and that A makes connection with C, there will be a path from A and C and the magnet coil U to the relay coil V, causing K, W, X and M to make contact. The circuit will then be starting with the right-field coil through the motor fields to M and X through the right-hand armature lead W and contact K and to the line. The motor will then run in the opposite direction and will wind the cable on the drum N. This causes the movable sheaves E to lower, which will take up the cable connecting the valves and close the live-steam valve if it should be open; if it is closed, it will open the exhaust valve a little, because when the sheaves E move downward they cause the contact C to move upward, breaking connection with A and opening the circuit through the relay coil V. This causes the relay to assume its normal position, opening the motor

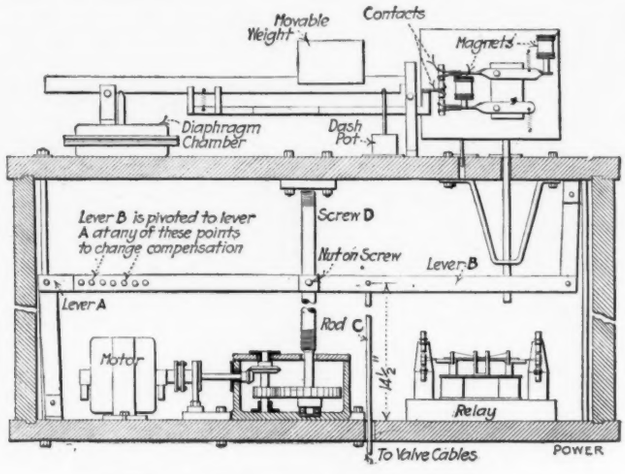


FIG. 2. THE IMPROVED REGULATOR

circuit and stopping the motor. If the pressure still goes up a little, this cycle of operation will be repeated until a balance is obtained at the weighted balance arm.

The amount of compensation, however, has been so proportioned that more than one movement of the valves seldom occurs, immediately following another. The regulator to be used on the other machine, while essentially the same so far as operation is concerned, varies mechanically.

The arrangement of the diaphragm lever and its movable weight is practically the same, as are the contacts. A dashpot is used. Perhaps the greatest difference in the two regulators lies in the manner of imparting power to the valve cables and in the type of motor.

With the regulator, Fig. 2, there is a three-phase motor directly connected to a lever to work the cable, through a train of gears in an oil-tight case. This does away with the necessity of belting the motor and also with a drum to wind and unwind the cable controlling the valves.

In considering the action of the regulator, starting at

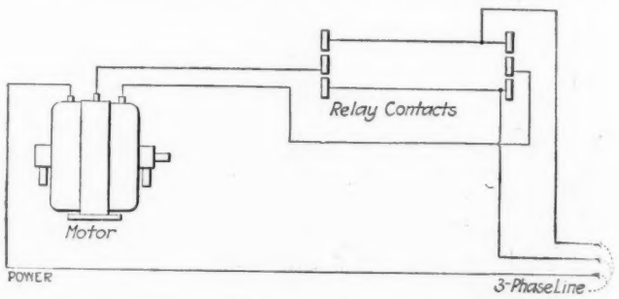


FIG. 3. WIRING OF THE THREE-PHASE MOTOR

the motor, the action of the contacts and the relay is the same as has been described. The motor is connected to a screw D through the gears shown, there being a flexible coupling between the motor and gear shaft. The screw D carries a nut to which the lever A is attached and serves to move the lever up and down.

Lever A is pivoted at the left end to a link which is fast to the bottom of the case, which contains all the parts.

At the right of the lever A is attached the rod C which works the valves, its operation being the same as the other regulator.

The lever B is pivoted at the right end to a link made fast at the top of the regulator case and at the left to the lever A at one of the numerous holes shown, thus increasing or diminishing the amount of compensation. Once properly adjusted, it need not be changed.

If the pressure drops, the motor will be started by the action of contacts A and B, Fig. 1, in a direction to move the nut down on the screw D carrying with it the lever A, which will lower B until the contact B breaks with A, stopping the motor. If the pressure rises, the reverse will take place.

The wiring of the three-phase motor is shown in Fig. 3. This motor is wound for 40 cycles, 220 volts, and is rated at $^1/_6$ hp. at 1160 r.p.m. One wire from the three-phase supply runs direct to the motor and is not opened at any time. The direction of rotation of the motor is changed by reversing the two line wires going to the relay.

Decoration Influence Illumination—The reason the color of the interior of a room influences its illumination is that an object absorbs rays of light of a color different from its own and reflects the rays similar to its own. Grass, for example, reflects the rays of green in the sunlight and absorbs most others. Therefore it is a poor reflector of sunlight. Hence, the necessity of ascertaining the quality—the color composition—of a source of light and decorating in colors similar to those predominating in the light.

Relative Strain on Boiler Seams—It is well to remember that the strain on a unit section in a longitudinal direction (lengthwise) on a boiler of any given size is just one-half that in a circumferencial direction.

Facilities for Plant-Repair Work

By Lewis Jones

SYNOPSIS—Necessity often causes unusual means to be resorted to and produces modification in types of machines used. A few of these are shown and described.

Many times the tools and machines for doing repair work about a power plant prove interesting by reason of the skill and ingenuity displayed in their arrangement and use in cases of emergency.

Fig. 1 is a general view of such a shop. The equipment is a 16-in. swing lathe driven by an old veteran of a motor to be seen in the corner; an emery grinder driven by an independent motor, and a drill press driven by a small motor, to be seen on top of the machine. At the time this photograph was taken, an interesting job was under way on the hacksaw in the foreground, i.e., a 14-in. pipe being cut to length with a hacksaw. The largest lathe would just swing a pipe of this size over the ways and not permit the tool carriage to be used for cutting off, but when the pipe was cut to length, it could then be threaded from the end with an offset tool.

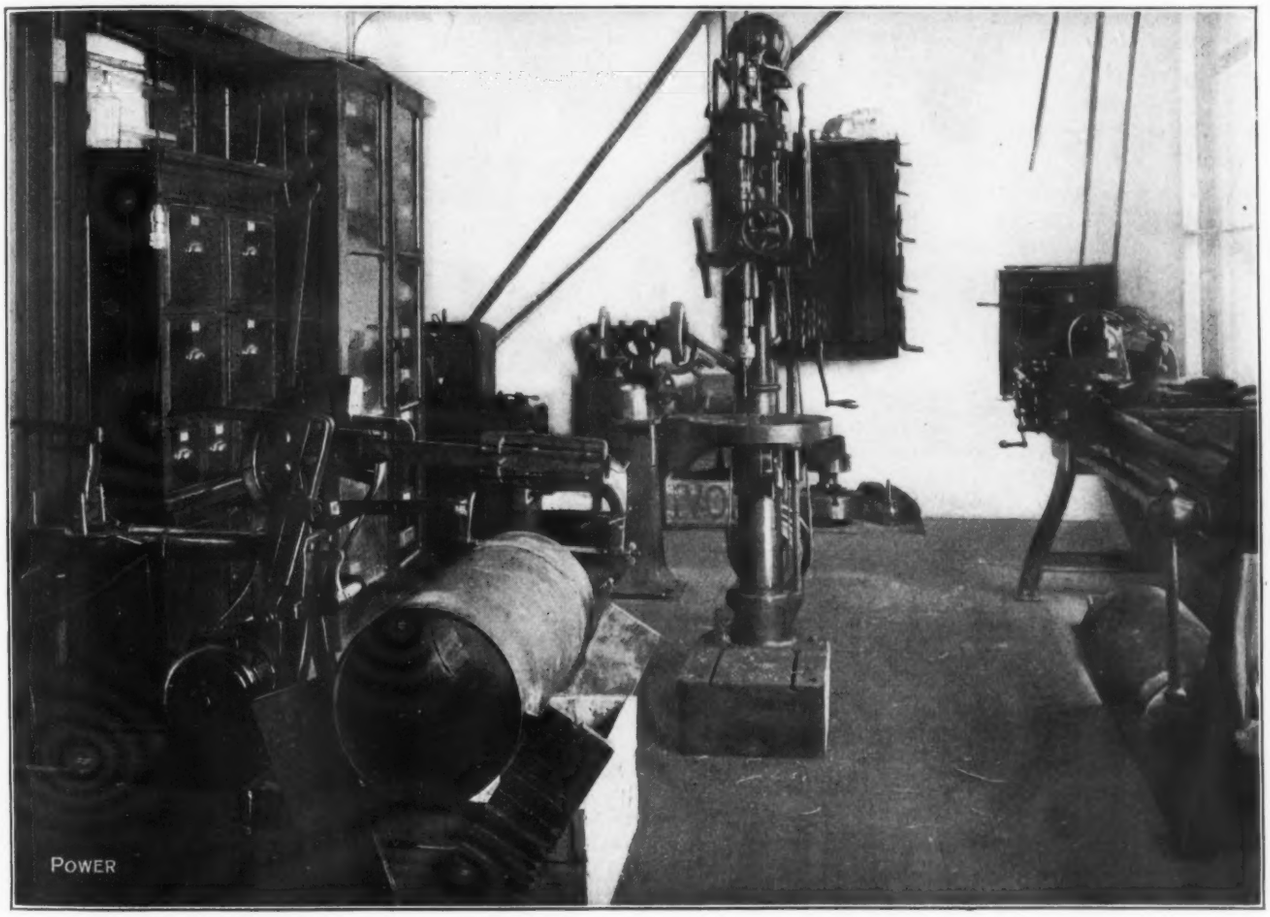


Fig. 1. General View of a Private Repair Shop

It was a matter of choice whether the work should be done on the premises, where the threads had to match a bad lot of flanges, or ship them 40 miles and back to have the work done in another shop.

The saw frame and guide were reversed from their normal position so that they extended beyond the rear end of the machine, and the pipe was laid on the top of a shipping box to which slant cleats had been nailed. The dark line on the inside of the pipe is the saw cut, and it will be seen that the saw hardly reached through the wall of the pipe before the ends of the frame began to strike at each stroke; therefore the pipe had to be rotated slightly at frequent intervals with a monkey-wrench on the end of the pipe, and since no clamping was necessary, this could be done while the saw was in motion. It was found best to allow the pipe to rest on the edge of the box rather than in the V-notch formed by the cleats, and the slight motion taken up by a wedge, because in that way the pipe was always level.

The actual time required to thus cut a pipe was less probably than would have been necessary to center and cut it off with a tool in a lathe. The clutch pulley on the saws so obviated the necessity for shifting the belt that the motor set directly below the shaft needed the standard-width pulley only. A flexible cord to a lamp socket was used so that the whole machine could be shifted to suit the work.

Fig. 2 shows the compact arrangement whereby one motor drives an emery grinder and a small drill press, making a handy combination for power-house work.

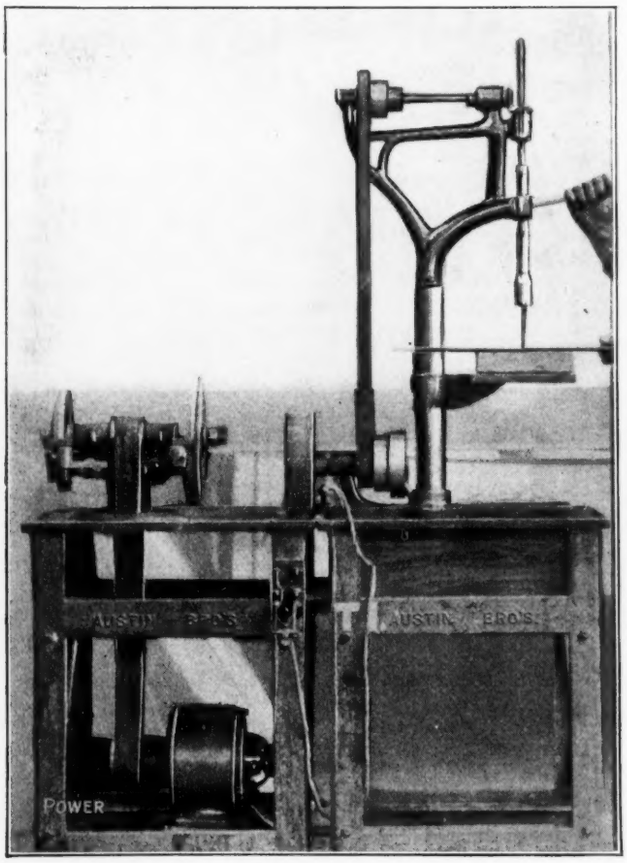


FIG. 2. A COMPACT UNIT

Fig. 3 shows a motor-driven, 6-in. pipe-threading machine. The motor is mounted above the machine on studs similar to the others, which will be described later,

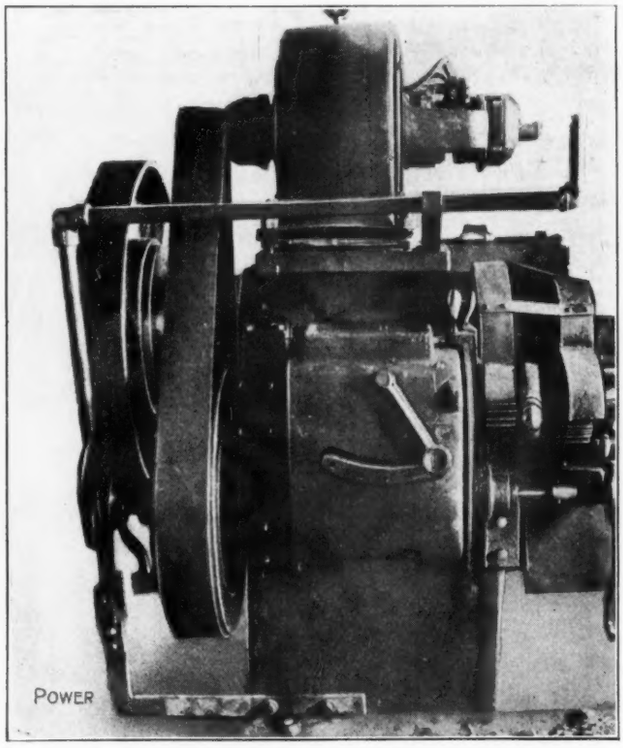
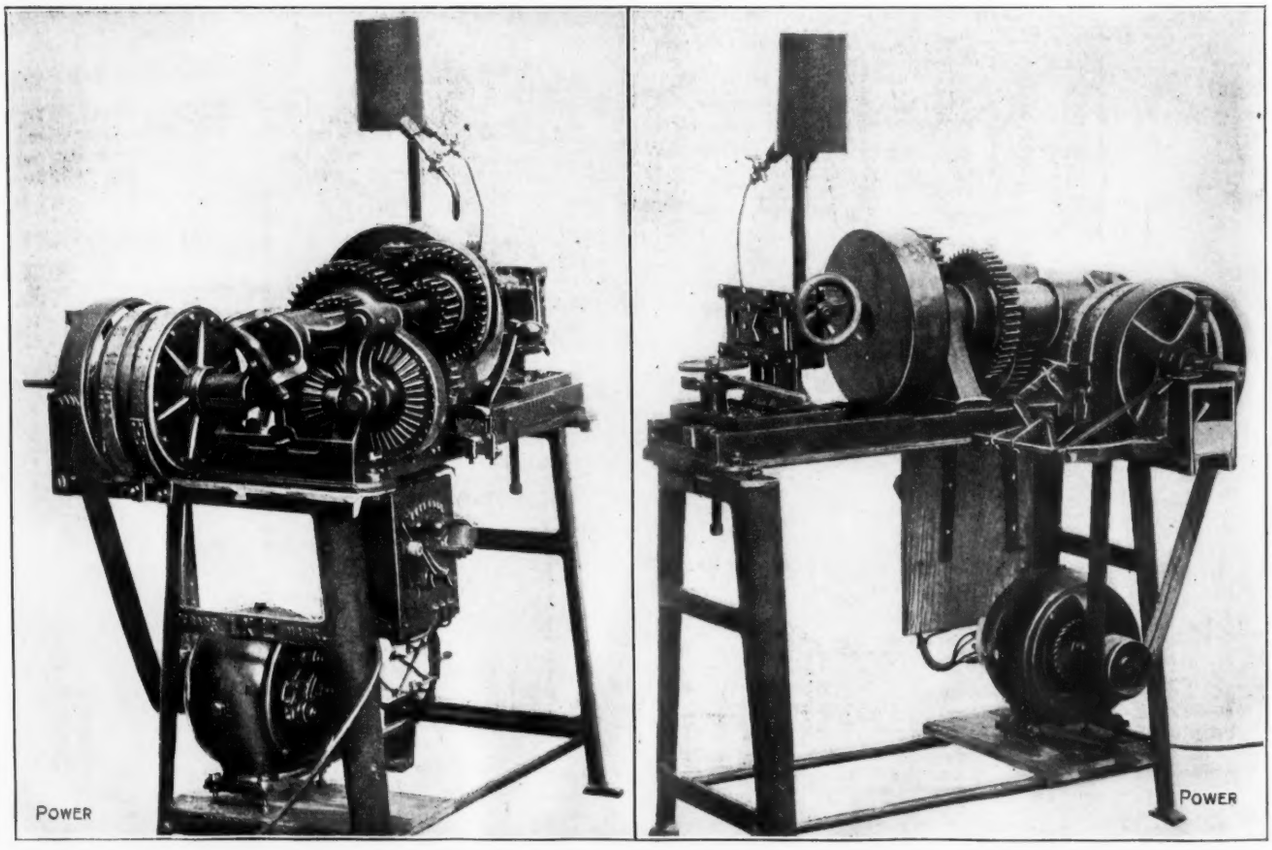


FIG. 3. A SIX-INCH PIPE-MACHINE DRIVE



FIGS. 4 AND 5. UNIQUE DRIVE ON A PIPE MACHINE

and drives the clutch pulley on the machine. When bought the machine was intended to be driven in the regular way; that is, the motor was to be belted to a countershaft, which was belted to another by a straight and crossed belt, and from this second countershaft to the machine. The advantages are obvious in dispensing with three of the four belts, and the one remaining can be tightened at will by lifting the motor. When it is necessary to reverse the machine, which is not frequent, a double-throw switch on the field lines is used.

Probably the most interesting of the group are Figs. 4 and 5, which show a motor drive on an old-style Saunders pipe machine for sizes up to 2 in. The head stock was reversed to get the drive away from the operator, and it was also set over on its base 2½ in. toward the operator's side to equalize the weight and to avoid too much overhang. A 3-in. channel iron was used for this purpose, making a rigid support for the outboard bearing. The drive has a planetary transmission of the familiar type used on automobiles, a gear reduction of 3 to 1 on the forward and slow reverse, and a high-speed reverse to be used after the die is slightly freed by about one full turn back at slow speed. All the motions are controlled by a single lever and without reversing the motor. This lever is shifted toward the die-carriage for threading, and in the opposite direction for backing out; in the central position it is pulled sidewise for high-speed backing out. All the motions are friction-clutch controlled, therefore no sudden shock is thrown on the gears or motor and no two clutches can be engaged at the same time. A high-speed motor was selected on account of its light weight.

The gear reduction allows high belt speed without having to use large pulleys. The motor is mounted on the frame almost directly below the drive shaft on four adjusting studs, being raised or lowered on these studs to adjust the belt tension, and held in position by locknuts. The illustrations show the method of mounting these motors, which has proved satisfactory in sizes up to 25 kw. As the whole outfit is mounted on the same stand, it is easily transferred from one job to another and need not be bolted down.

Weir Measurement of Condensate and Makeup

An interesting application of the liquid meter, which in this case is the Lea V-notch recorder, is that for measuring the different sources of the total boiler-feed water in a plant operating condensing and using economizers. There are three recorders mounted on a meter tank designed for that many, the tank being planned on a closed heater section.

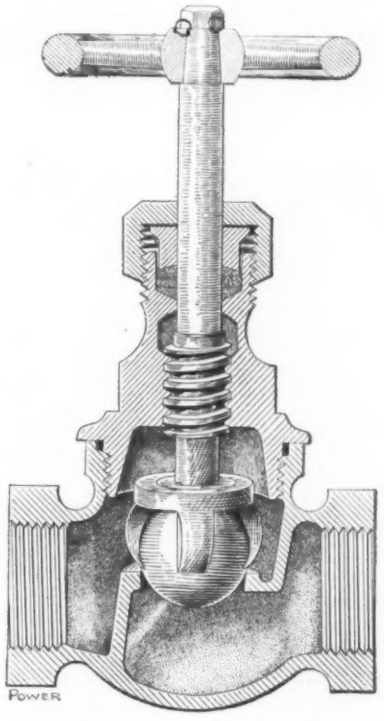
The idea of the multiple recorder apparatus is to measure the discharge from more than one source. For example, in this plant there are two condensing turbines, therefore there is a recorder and its hotwell to measure the condensate from each turbine separately; the third recorder measures the makeup water. A balanced control valve in the makeup water line, operated by the usual float and lever in the main hotwell below the meters, automatically admits the necessary amount of makeup when there is not enough condensate returning to feed the boilers. The feed pump draws its supply directly from the bottom of the hotwell.

As it is desirable to have the feed water enter the economizers at 150 to 160 deg., to prevent sweating of the tubes, and as the condensate leaves the condensers at between 80 and 90 deg. F. and the makeup water enters the hotwell at a considerably lower temperature (usually dependent upon the outside atmospheric temperature), it becomes necessary to introduce a heating element to raise the temperature of the boiler feed to the proper entering temperature for the economizers. This condition has been met by introducing in the hotwell of the meter a tubular heater, which receives exhaust steam from the boiler-feed pump or some other auxiliary.

In the Hartford Medical School, Boston, Mass., this application of the recorder is used to measure returns from three different buildings.

Farrell Ball Valve

The special feature of this valve is that a ball of hard-rolled brass or noncorrodible nickel steel is used, as illustrated, instead of an ordinary disk. The ball is held



FARRELL BALL VALVE

loosely by the claws which rest and revolve freely on a flange on the end of the spindle, the flanged end of which is concaved and bears directly on the top of the ball, holding it rigidly on the valve seat when closed.

This bronze valve, in pipe sizes from ½ to 2 in., is made by the Pratt & Cady Co., Inc., Hartford, Conn.

Evidence of Earnest Effort in the Cause of Smoke Abatement—About 60 railroad executives met on Aug. 4, at the call of Chief J. W. Henderson, of the division of smoke inspection in Pittsburgh, to find out what the railroads are doing to abate smoke in that city. Three months ago men were appointed to watch the different engine crews and the result has been that it was decided that the success of the plan remains with the engine crews, and that it is up to them to hold the smoke emitted to the minimum. Progress is undoubtedly being made in this city in the smoke-abatement problem.

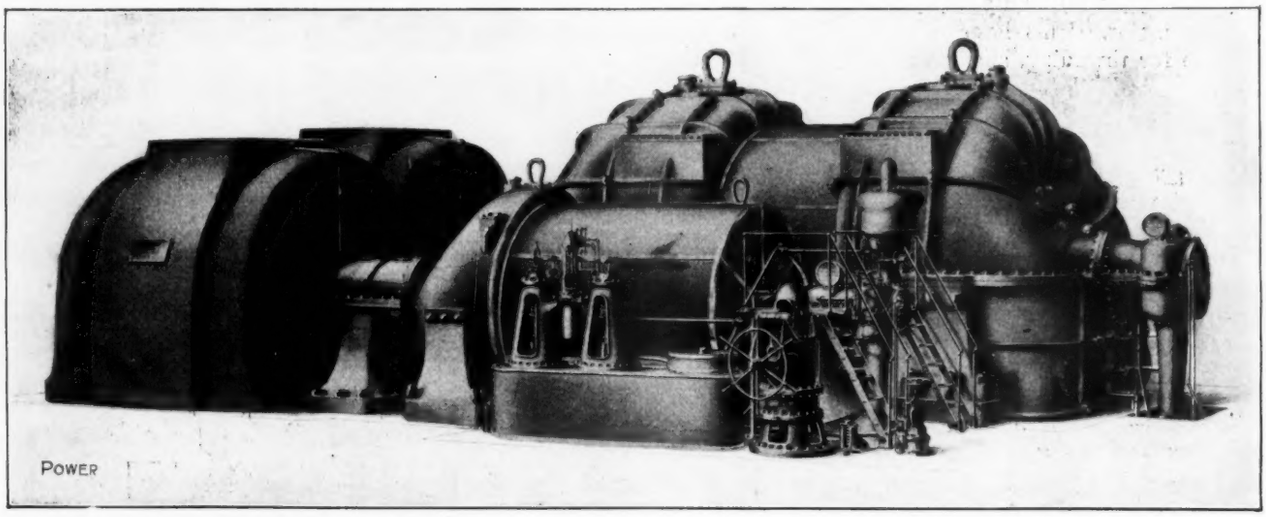
Compound Steam Turbines

By Francis Hodgkinson*

In some recent turbine installations, and in the case of some machines in the process of construction, two cylinders have been employed for a single turbine-generator unit, the steam passing serially through the turbine elements as in a two-stage compound engine. In some instances, the turbine elements have been arranged tandem fashion, coupled to a single generator, and other units not yet in operation will comprise two turbine elements driving separate generators. By many this will no doubt be regarded as a strange proceeding and a retrogression to obsolete practice, inasmuch as several tandem-compound machines of from 1000 to 2000-kw. capacity were built in this country as far back as 1900, subsequent to which the design was abandoned. These old two-cylinder turbines have all proved remarkably economical machines, and are still performing excellently from every standpoint, except where they have been replaced with machines of greater capacity.

This single-cylinder Hartford machine was very much the largest turbine that had been attempted, and excited considerable comment, particularly among European turbine builders, it being regarded by them as a big undertaking to construct a machine of such large capacity in a single cylinder. The effect of the Hartford installation was to very materially increase the range of capacity in single-cylinder turbine construction on both sides of the Atlantic. At the same time, engineers in this country were much impressed by the simplicity and safety of construction offered by the double-cylinder design, which resulted in about 16 machines being built by the Westinghouse Machine Co., ranging in capacity from 1000 to 2000 kw., operating at speeds of from 1200 to 1800 r.p.m.

There was an additional reason which led certain engineers to the two-cylinder design at that time, viz., the fact that reheaters were very fashionable among builders



30,000-Kw. Westinghouse-Parsons Steam-Turbine-Driven Unit

The single-flow high-pressure section runs at 1500 and the double-flow low-pressure section at 750 revolutions per minute

Many of the reasons which have led to the present adoption of the two-cylinder construction are the same as dictated that design in the past.

Up to 1900 few turbines had been constructed of greater capacity than 500 kw. At that time, however, a machine of approximately 2000-kw. capacity, operating at 1200 r.p.m., which was constructed with but a single cylinder, was installed at the plant of the Hartford (Conn.) Electric Light Co. Simultaneously, a machine of 1000-kw. capacity, in which the expansion was carried out in two separate turbine elements arranged turbine fashion, was built by C. A. Parsons & Co. for the Elberfield Corporation of Germany. The results obtained on these two machines are reported to have been as follows:

Elberfield Turbine		Hartford Turbine
1250 kw.	Load	1998 kw.
145 lb.	Steam pressure	155 lb.
18.5° F.	Superheat	55° F.
28.1 in.	Vacuum	27.3 in.
19.6 lb.	Steam consumption per kw.-hr.	19.1 lb.

*Engineer turbine department, Westinghouse Machine Co.

of reciprocating engines. However, for such sizes of machines the two-cylinder construction was soon abandoned because of the enormous length of the units and their greater cost; a 1250-kw. turbine-generator unit was 42 ft. 6 in. long. Single-cylinder machines have now been successfully built up to 20,000-kw. capacity, although the advantages of the two-cylinder construction have been fully appreciated for large-size machines, and still are, if for no other reason than that either element of a compound turbine deals with substantially half the heat drop, and consequently is not subjected to mechanical limitations. No compromises to the blade distribution or number of turbine elements employed need be made for mechanical or structural reasons. The advantages of the two-cylinder construction might be enumerated as follows, these reasons having more force the larger the capacity of the machine:

1—Smaller cylinder structure.

2—Smaller temperature range within a single cylinder.

3—No limitations to the design preventing the attainment of the highest efficiency.

4—Possibility of separating moisture midway in the expansion of the steam.

In the case of machines of 20,000-kw. capacity or above, intended for operation in large power houses where the units, if operating at all, are running at or near their most efficient load, considerable capital investment is warranted for the sake of a comparatively small actual gain in steam consumption; and for a unit of such capacity it is considered that the greater initial cost of the two-cylinder construction is entirely warranted.

In the instance of some 30,000-kw. turbines about to be installed, an innovation in two-cylinder construction has been made in having each turbine element drive a separate generator, each operating at a different synchronous speed, the speed selected being that which will permit the design of turbine best adapted for the expansion range involved. In any turbine designed to completely expand the steam, the low-pressure blading limits the capacity. Considerations of centrifugal force limit the diameter of the last disk or drum. With this at a given diameter, there is a limiting dimension of blade which may be employed. A blade height of 15 per cent., or at most 20 per cent., of the diameter of the drum is not exceeded. To do so involves losses due to the disparity of tip speed and root speed of the blades, there being no steam speeds to best satisfy the two extremes. With the given dimensions of blade passages, the weight of steam which may be passed depends on the desired limit of expansion, *i.e.*, the vacuum to which the turbine is to expand and the desired velocity of steam, which latter should bear a definite ratio to the blade speed.

In the case of reaction machines designed for high vacuum, and with blade speeds of 400 ft. per second or more, it is customary to proportion them so that the steam velocity in the last row of blades approaches the critical point at full load. This so called critical velocity is the highest obtainable with a rounded orifice and without recourse to diverging nozzles. This critical velocity varies from about 1500 ft. per second in the case of high-pressure ranges to about 1200 ft. per second for exhaust conditions. It is the point of expansion in a nozzle where the rate of increase of steam volume is equal to the rate of increase of velocity. Above this point, the velocity increases more rapidly than the volume, and below it the volume increases more rapidly than the velocity.

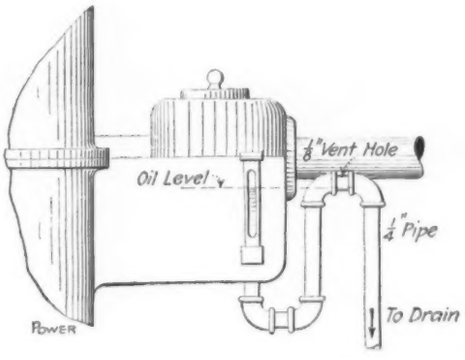
While the limitation of turbine capacity at the low-pressure end is that of providing area on account of the large number of expansions involved, the problem at the high-pressure end of the turbine is in dealing efficiently with the very minute volumes of steam there involved. Plainly, therefore, the best speed having been selected for the low-pressure portion, the design of the high-pressure portion is very much simplified by being able to employ a higher rotative speed. Hence for the 30,000-kw. machines, the high-pressure turbine is a single-flow reaction element operating at 1500 r.p.m., while the low-pressure is a double-flow machine operating at 750 r.p.m., the general design being styled "cross-compound" unit, the general appearance of which is shown in the illustration. The difference in electrical efficiency between a single unit of 30,000 kw. and a 30,000-kw. machine comprising two elements is not material and is far more than offset by the advantages to the turbine of the two rotative speeds. This cross-compound principle will permit of turbines being designed in what are, in effect, single units up to 50,000 or 100,000 kw. capacity, should machines of such large capacities be required. In the case of such sizes, three stages would probably be employed.

Saving Oil in a Power Plant

By Jesse L. Best

One of the numerous leaks that may exist in a power plant is the loss of lubricating oil from auxiliary bearings such as a small steam turbine, especially when it is operating under high back pressure. The same applies to pumps having packing glands close to the bearings. Usually, these machines are equipped with good ring oiling bearings requiring little attention, but if a leak should develop, unnoticed at once by the operator, the oil will soon be flooded out and then there is a hot bearing with its usual accompaniment of wasted oil, and in some cases, a shutdown of the unit. If it happens often, a new bearing is required.

In a certain power plant several small turbines operating on back pressures of from 2 to 15 lb. had been giving trouble from leaky packing glands. Part of the



Water Drain from Oil Reservoir

steam blowing into the bearings and being condensed, would raise the level of the oil in the bearing and flood it out. The resulting hot bearing was annoying and expensive, especially as the units were required to operate twenty-four hours a day.

To overcome this trouble the writer connected ¼-in. nipples and ells to a bearing as shown in the illustration. On the first bearing a saving of ½ gal. of oil per day was made, and in a week this paid for the time and material. In addition to this saving, the cost of attendance is less and the service more continuous.

As the illustration shows, the idea is to automatically drain the water from the bottom of the bearing without taking along any oil. The oil level cannot be any higher than the overflow or top nipple.

To make this device operate most economically, the piping to the bottom of the bearing should first be filled with water; then oil is poured into the bearing up to the proper level. As soon as any water accumulates in the bearing the oil level will tend to rise and the water in

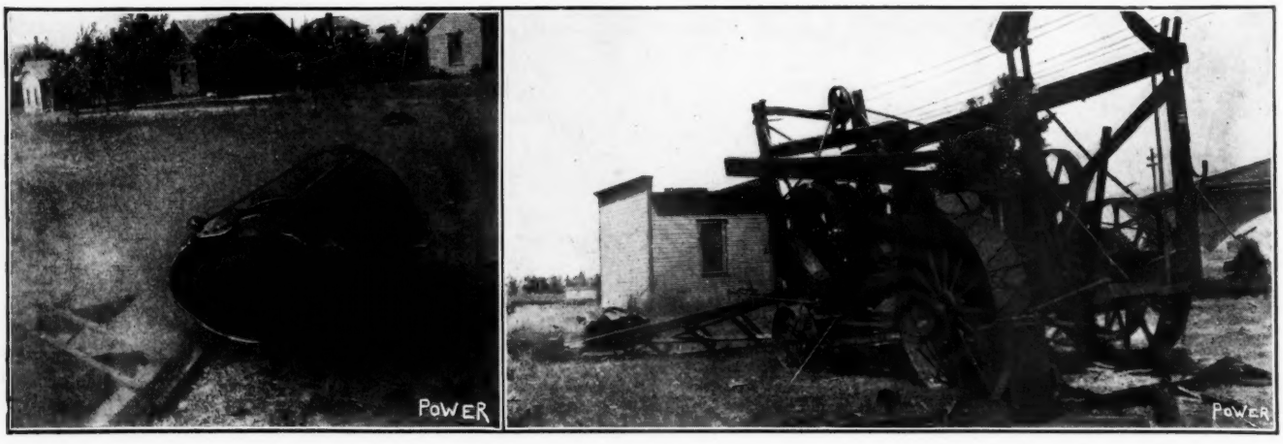
the bottom of the bearing will be forced out through the overflow.

Bearings equipped with this device have run for days without attention, when before they were a constant source of annoyance. It takes only a little vapor from the packing to gradually fill up a bearing. The proper thing, of course, is to keep the packings in first-class order, but the above precaution can be taken at such small expense that it will be found worth while.

Boiler on a Well Driller Explodes

A vertical boiler attached to a Keystone well driller exploded on Aug. 13, at Leipsic, Ohio, seriously injuring two men who were standing on the rear platform at the time.

The boiler had not been in use for about two years and the sheets had corroded almost through in some places.



Boiler and Drilling Rig after the Explosion

Soft-Coal Smoke as Legal Nuisance

By A. L. H. Street

SYNOPSIS—Mere discharge of dense smoke does not constitute a nuisance. Whether a property owner may enjoin continuance of practice or recover damages is largely dependent upon location and other particular circumstances. Power of cities and legislatures to impose restrictions. What the higher courts have decided.

From the large body of judicial decisions which have been announced by the appellate courts of the country on the subject of the remedies of individuals and the public against the emission of smoke from power plants, the following may be said:

The mere fact that dense smoke is emitted from a stack does not constitute an actionable nuisance. "It only becomes a nuisance," holds the Minnesota Supreme Court, "when it permeates the air surrounding people and invades their residences and places of occupation." (State vs. Chicago, Milwaukee & St. Paul Ry. Co., 130 *Northwestern Reporter* 545.) A similar conclusion has been reached by the courts of other states. The degree of freedom from smoke in the atmosphere to which one is entitled is relative, and depends on the locality and the prevailing use to which property there is put. What might constitute a nuisance in one locality would be what reasonably might be anticipated in another. Whether smoke or noise constitutes a nuisance depends on the evidence in each particular case. (Iowa Supreme Court, 118 *Northwestern Reporter* 786.) In this case (McGill vs. Pintsch Compressing Co.) the court, finding that the air must be more heavily laden with smoke in one locality than in another, in the reasonable enjoyment of property, declares: "Only when an unreasonable amount of smoke is emitted or is emitted in an unreasonable manner so as to inflict injury on another will the courts interfere. There is no precise test by which to determine when the smoke imparted to the atmosphere is of a greater degree than is permissible. The injury must be tangible. Mere annoyance is not enough. It must be such as to render the occupancy of the complainant's premises physically uncomfortable to a person of ordinary sensibilities for the purposes to which it is devoted."

Validity of Laws and Ordinances

The emission of dense smoke into the atmosphere in populous cities may be declared by the legislative department to be a public nuisance. (Minnesota Supreme Court, 130 *Northwestern Reporter* 545.) In this case the court upheld the validity of an ordinance of the city of Minneapolis which prohibits the use of soft coal in traction engines and locomotives within the city. It was decided that the ordinance was not unconstitutional as constituting class legislation, because it did not extend to stationary engines, since there is a difference in the tendency of that class of engines to produce a nuisance, and since the city had taken other appropriate steps to prevent emission of smoke from stationary plants. The Minnesota court said: "It is elementary that the legisla-

ture cannot prevent a lawful use of property by declaring a certain use to be a nuisance which is not in fact a nuisance, and prohibiting such use. On the other hand, it is equally clear that acts or conditions which are detrimental to the comfort and health of the community may be effectively declared nuisances by the legislature, and the fact that the use or value of property as existing under the common law is thereby injuriously affected does not necessarily bring such legislative action within any constitutional prohibition."

A law enacted by the New York Legislature in 1895, providing that no factory, engine room or electrical station should use soft coal for fuel within a radius of four miles of the Brooklyn city hall, except for heating and welding iron or steel, was upheld by the Appellate Division of the New York Supreme Court as being a proper exercise of the state's police power. (City of Brooklyn vs. Nassau Electric R.R. Co., 61 *New York Supplement* 33.) In a later case (City of New York vs. H. W. Johns-Manville Co., 85 *New York Supplement* 757) it was held that there was a showing of violation of the law on proof that about 20 per cent. of the coal used by defendant was soft coal.

An ordinance of the city of Indianapolis declaring the emission of dense smoke from any chimney, etc., within the corporate limits to be a public nuisance, irrespective of the particular locality, was sustained by the Supreme Court of Indiana, although the ordinance excepted from its operation private residences. (Bowers vs. City of Indianapolis, 81 *Northeastern Reporter* 1097.)

An ordinance of the city of Chicago forbidding dis charge of dense smoke into the open air has been upheld. (161 *Illinois Appellate Court Reports* 307.)

The St. Louis Court of Appeals has declared that the provision of the Missouri statutes which makes it a good defense to a prosecution for discharging dense smoke into the open air that there is no known practicable device, etc., by application of which discharge of dense smoke could have been prevented, is not available as a defense in a prosecution for violating the anti-smoke law of that state, where the offender installs or unreasonably maintains boilers to which no smoke abatement appliance can be attached. (State vs. Dower, 114 *Southwestern Reporter* 1104.) This law makes it a misdemeanor to discharge dense smoke into the open air in cities having more than 100,000 population.

But, in a late case, the New Jersey Supreme Court has held that an ordinance forbidding the emission of smoke from any locomotive or engine stack within the limits of Jersey City, containing soot or other substance in sufficient quantity to injure health or property, is unreasonable, so far as locomotives are concerned, as being in derogation of a railway company's right to emit such smoke as is reasonably necessary for the proper operation of its road. (84 *Atlantic Reporter* 697.) The court did not pass on the validity of the ordinance, so far as concerns stationary engines, although it was intimated that the regulation might be valid as to that class, since a similar ordinance has been upheld as to factories in a similar case. And, in a still later case, the same court held that a railroad company may be indicted for emitting smoke and gas from its locomotives in greater quantities than is required for the proper operation of the road. (87 *Atlantic Reporter* 86.)

The New York Court of Appeals has held that the use of soft coal in a factory, situated in a country district suitable for country homes, so that black smoke therefrom, great in volume and dense in quality, envelops and discolors a neighboring dwelling, causing discomfort and pecuniary loss to the occupants, is a nuisance which may be enjoined, if the use of soft coal is not essential in operating the factory and is not a reasonable use of the manufacturer's property. (McCarty vs. Natural Carbonic Gas Co., 81 *Northwestern Reporter* 549). Mr. Justice O'Brien dissented from the decision in this case on the grounds that the neighborhood in question was so sparsely settled that it might properly be called neither a residence, factory, nor business neighborhood, and that the defendant was not bound to unduly increase its fuel expense in order to secure greater comfort for plaintiff in the enjoyment of his home. He said: "Whatever we decide in this case must apply to every manufactory or manufacturing establishment in this state. It is a question of comfort on the part of the plaintiff. On the part of the defendant it certainly is a question of the right to conduct a business with good judgment and reasonable economy."

But the Pennsylvania Supreme Court has refused to enjoin the use of bituminous or semibituminous coal in an industry where it was found that such fuel was indispensable to the proper operation of defendant's iron works; deciding that any damages sustained by plaintiff could be compensated fully by a money judgment. (Richards' Appeal, 57 *Pennsylvania State Reports* 105.) The court said, however, that an injunction might be proper if the injury could be avoided by the use of other fuel equally good and available, or if smoke consumers could be installed at reasonable expense.

And, in a Massachusetts case (Downing vs. Elliott, 64 *Northwestern Reporter* 201), the Supreme Judicial Court refused to grant an injunction against the use of soft coal at an industrial plant, although it resulted in soot and cinders being deposited upon the ice of a pond, from which plaintiff derived an ice supply, where it appeared that the damage to plaintiff was insignificant as compared with that resulting from other causes, and that the use of such fuel was more economical for defendant. The court even refused to award a money judgment. The opinion in this case contains the following reasoning: "In thickly settled communities absolute purity of atmosphere is out of the question; and the more thickly settled the community is, and the more varied are the kinds of business, the more will the atmosphere be unavoidably impregnated with impurities. This is one of the inconveniences, if it is an inconvenience, which everyone who lives in a populous neighborhood must suffer." The court qualifies this statement, however, by saying that the fact that the atmosphere is already impure does not excuse one in increasing the impurity to the discomfort of others.

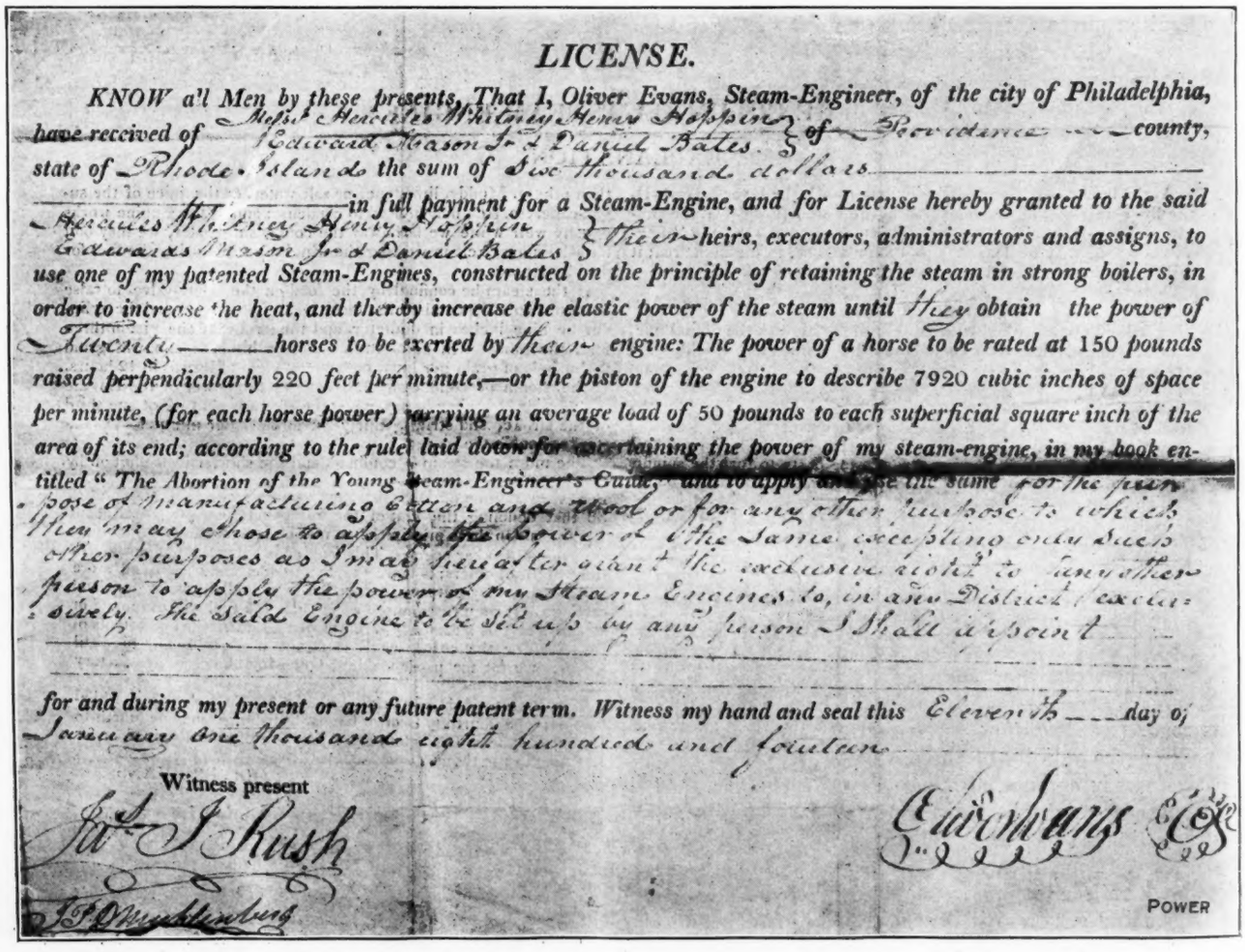
In a Tennessee case, the Supreme Court reversed a judgment which enjoined the owner of a smoke-stack on a power plant from permitting smoke to escape at an elevation less than that of the roof of a near-by 15-story office building. (Union Planters' Bank & Trust Co. vs. Memphis Hotel Co., 139 *Southwestern Reporter* 715.) The court held that the injunction constituted an excess of the lower court's powers as in effect requiring the stack to be raised to a height which might injuriously affect the public safety, and said: "This smoke has to

escape, and there must be smoke-stacks, and whenever one building is higher than another it will suffer from the smoke issuing from the stacks of the lower, unless some means could be devised whereby all stacks could be made a uniform height, and even that would not obviate the trouble, because of the tendency of smoke to descend in damp weather, and because of downward eddies in air currents which exist in the neighborhood of high buildings."

When a property owner establishes a right to be awarded damages on account of the maintenance of a "smoke nuisance," they are to be measured according to whether the injury is merely to the enjoyment of the property or to the property itself; in the absence of injury to the property itself, the measure of damages is the diminution in the rental value caused by the maintenance of the nuisance. This depreciation must result from interference with the comfortable enjoyment of the premises, and not from the mere prejudice against the property in consequence of its proximity to the plant, for the latter depreciation cannot be said to have been caused by the injury. But when permanent injury to the property is done, the owner is entitled to recover the consequent diminution in the value of the property. (Iowa Supreme Court, McGill vs. Pintsch Compressing Co., 118 *Northwestern Reporter* 786.)

An Oliver Evans License of 1814

When John P. Farnsworth, President of the Providence Dyeing, Bleaching and Calendering Co., welcomed the recent Power Show to Providence on behalf of the Chamber of Commerce, he exhibited a license granted to the founders of his company in 1814, by Oliver Evans, authorizing the use by that company of one of Evans' patented engines, and bearing his own signature. The accompanying illustrations are reproductions of photographs of the face and reverse of this license. The company holds also the patent for the first friction calender ever made, transferred to them by the inventor, Wm. Smith, in the year 1809, the patent having been taken out in 1805, and being signed by Thos. Jefferson, President, and Jas. Matteson, Secretary of State. The first valve motions patented by Mr. Corliss were tried out on the engine in the Sabin St. plant of the same company. It was a walking beam engine with a capacity of about 150 hp.



LICENSE.

KNOW all Men by these presents, That I, Oliver Evans, Steam-Engineer, of the city of Philadelphia, have received of Messrs Hercules Whitney, Henry Hopkins, Edward Mason Jr & Daniel Bates *of* Providence *county, state of* Rhode Island *the sum of* five thousand dollars *in full payment for a Steam-Engine, and for License hereby granted to the said* Hercules Whitney, Henry Hopkins, Edwards Mason Jr & Daniel Bates *their heirs, executors, administrators and assigns, to use one of my patented Steam-Engines, constructed on the principle of retaining the steam in strong boilers, in order to increase the heat, and thereby increase the elastic power of the steam until they obtain the power of* Twenty *horses to be exerted by their engine: The power of a horse to be rated at* 150 *pounds raised perpendicularly* 220 *feet per minute,—or the piston of the engine to describe* 7920 *cubic inches of space per minute, (for each horse power) carrying an average load of* 50 *pounds to each superficial square inch of the area of its end; according to the rule laid down for ascertaining the power of my steam-engine, in my book entitled "The Abortion of the Young Steam-Engineer's Guide," and to apply and use the same for the purpose of manufacturing Cotton and Wool or for any other purpose to which they may chose to apply the power of the same excepting only such other purposes as I may hereafter grant the exclusive right to any other person to apply the power of my Steam Engines to, in any District exclusively. The said Engine to be set up by any person I shall appoint*

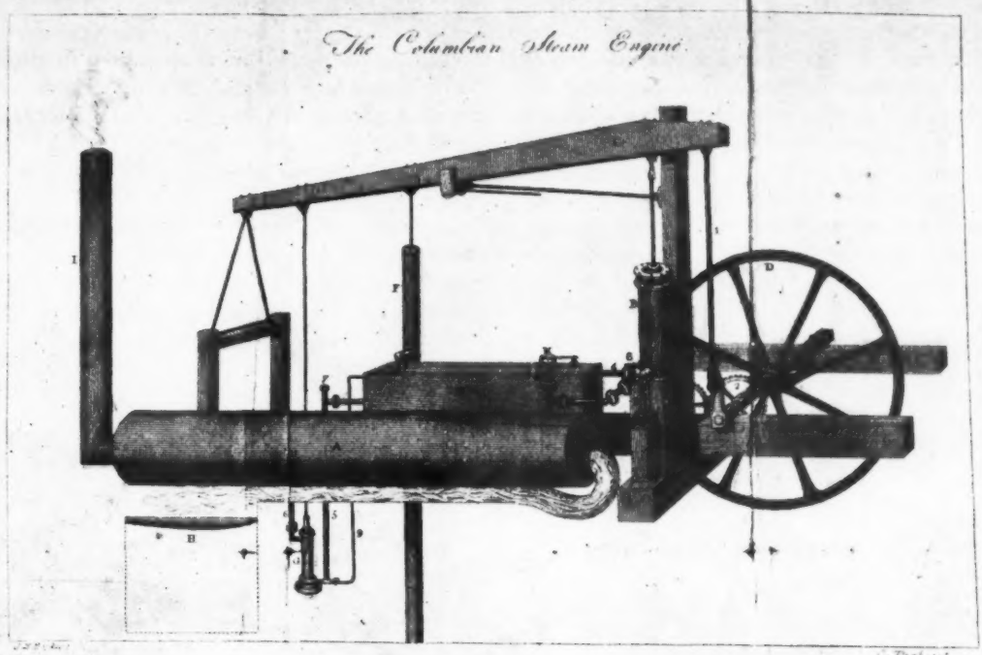
for and during my present or any future patent term. Witness my hand and seal this Eleventh *day of* January *one thousand eight hundred and fourteen*

Witness present

Ed Evans

POWER

License Granted by Oliver Evans in 1814 for the Use of One of His Steam Engines



THE COLUMBIAN STEAM-ENGINE.

EXPLANATION.

A, the boiler,—B, the working cylinder,—C, the lever beam,—D, the fly-wheel.—E, the condenser.—F, the water pump,—G, the supply pump,—H, the furnace,—I, the chimney flue,—K, the safety-valve, which may be loaded with 100 or 150lbs. to the inch area; it will never need more, and it must never be fastened down.

OPERATION.

The boiler being filled with pure water as high as the dotted line, and the fire applied, the smoke enters the center flue, which passes through the center of the water to ascend the flue I, and thus acts on a large surface.

When the steam lifts the safety-valve, it is then let into the cylinder by opening the throttle-valve, to drive the piston up and down, which, by rod 1, gives motion to the fly-wheel, and wheel 2 gives motion to a shaft, passing through the posts, to turn the spindle of the rotatory valves 3, 8, which lets the steam both off and on the cylinder at the proper time.

The steam escaping by pipe 4, curved and immersed in the water in box E, which is supplied by pump F, it is condensed, and the water formed, decends by pipe 5 into supply-pump G, and is forced into the boiler again by pipe 6.

But boiling decomposes water slowly, changing it into air incondensible. Therefore the snifting-valve 7 is necessary. This valve lifts at every puff of steam, and a small quantity of air escapes; and it shuts, and a vacuum is instantly formed, as the crank passes the dead points.

The small waste of water may be supplied by condensing part of the steam rising from the condensing water, to run down the Pipe 9, through a hole in the key of a stop-cock, $\frac{1}{8}$ parts of an inch diameter.—A small hole indeed to supply a boiler of twenty horses power.

No sediment can accumulate in the boiler, it being supplied by distill'd water. Therefore it will last much longer, and require less fuel than others. Muddy, limestone, or salt water, or the juice of the sugar-cane, &c. &c, may be used to condense; and as the Engine works equally well while we boil away the condensing water, we may boil for salt, sugar, &c., in working the Engine,—thus using the fuel for double puposes.

If the steam be confined by the load on the safety-valve, to raise its power to 100 pounds to the inch, area of the piston and the cylinder be nine inches in diameter, and the stroke of the piston three feet, the power will equal twenty horses hitched; and will grind 20 bushels of grain per hour, or saw 5000 feet of boards in 12 hours. If the steam be confined by 150 pounds, the power of the Engine will be equal to thirty horses, when the steam is shut off at one third of the stroke, and striking thirty-six strokes per minute.—Double strokes double the power.

The more the steam is confined, and the shorter it be shut off by the Regulator 8, the greater will be the power obtained by the fuel. For every addition of 30 degrees heat to the water doubles the power. So that doubling the heat of the water increases the power about 100 times. On these principles fuel may be lessened to one third part consumed by other engines. This Engine is not more than one fourth the weight of others; is more simple, durable, and cheap, and more suitable for every purpose; especially for propelling boats and land carriages. It requires no more water than the fuel will evaporate in steam, and this steam may be employed to warm the apartments of factories; or the condenser E could be used as a still to distil spirits; or a vat for paper making, boiler in a brewery, dye factory &c. &c.

The Patent Right now belongs one half to the Subscriber, Philadelphia; one fourth to George Evans, Pittsburg; and one fourth to Luther Stephens, Lexington, Ky. Apply to either for Engines, or for Licenses to use them.

OLIVER EVANS.

POWER

REVERSE OF LICENSE, EXPLAINING EVANS' ENGINE OF ONE HUNDRED YEARS AGO

Temperatures within Internal-Combustion Engines

A recent article in *Zeitschrift des Vereines deutscher Ingenieure* describes some interesting experiments to determine the rapidly changing temperatures within the cylinder of an internal-combustion engine, electrical measuring instruments being used.

The thermocouple shown in Fig. 1 is of chemically pure platinum and a platinum-rhodium alloy containing 10 per cent. rhodium. The tube or body is of good quality porcelain and in order to obtain an air-tight packing between the inside of the tube and the atmosphere, two conical pieces *e* and *f* of the same material as the corresponding wires, are welded to the wires. The free ends of the wires are led so far away from the cylinder as to render negligible the effect of radiated heat and maintain their temperature at that of the room, namely 20 deg. C.

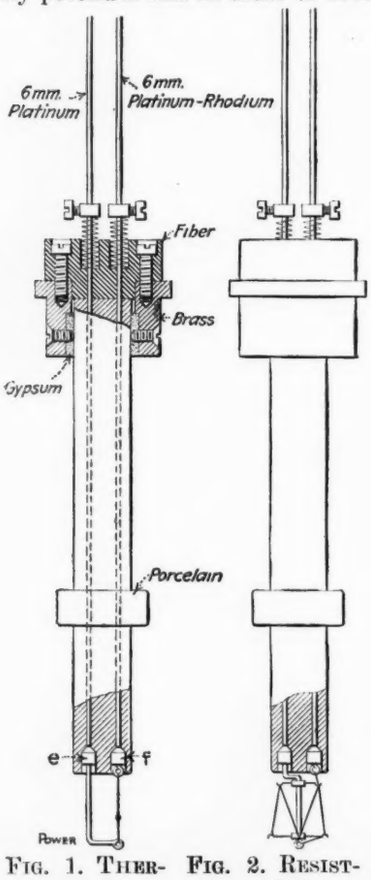


Fig. 1. Thermo Couple

Fig. 2. Resistance Pyrometer

The resistance pyrometer shown in Fig. 2, with which readings were also taken, is similar in construction to the thermocouple, except that the wires are of a platinum-iridium alloy (35 per cent. iridium), and the fire end strongly resembles the filament of a tungsten lamp.

For measuring the electromotive force set up in the thermocouple an Eintheven string galvanometer was selected, because of its very small inertia, the moving element being a gold string having a diameter of 0.0003 inch.

A 6-hp., 3⅛x3¾-in., two-cylinder gasoline engine was selected for the test. This was placed on a special frame so as to reduce vibration when running at a normal speed of 900 r.p.m., and thus not interfere with the sensitiveness of the galvanometer. Fig. 3 shows how the thermocouple was attached to the cylinder head.

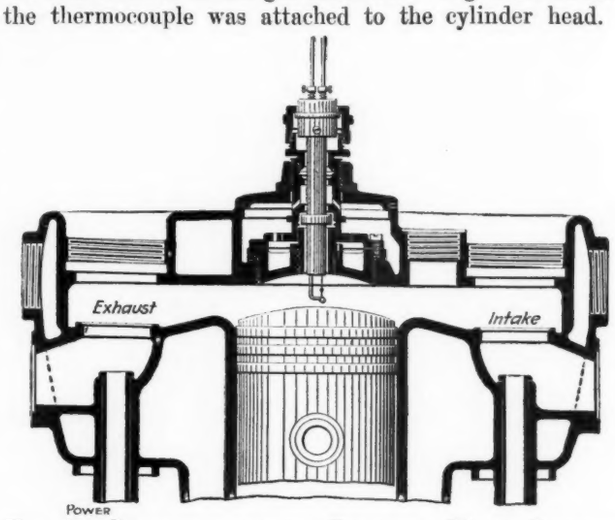


Fig. 3. Section through Cylinder Head, Showing Location of Thermocouple

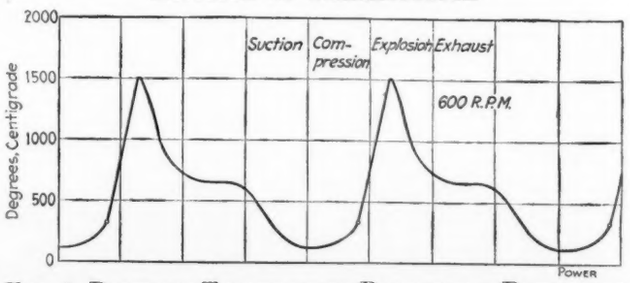


Fig. 5. Diagram Taken with Resistance Pyrometer

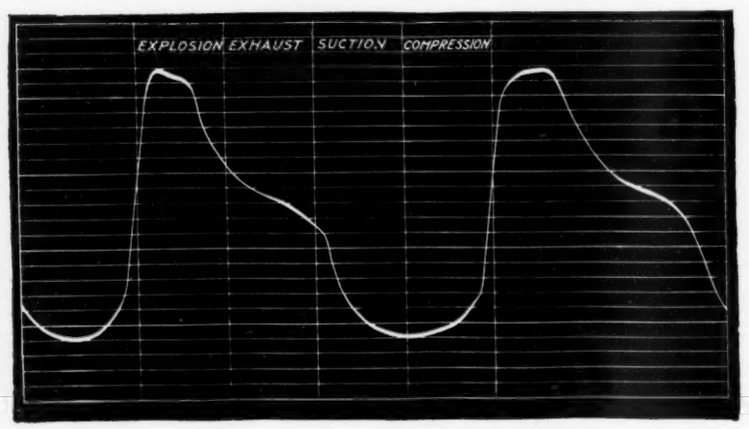


Fig. 4. Diagram with 0.03-Mm. Wire

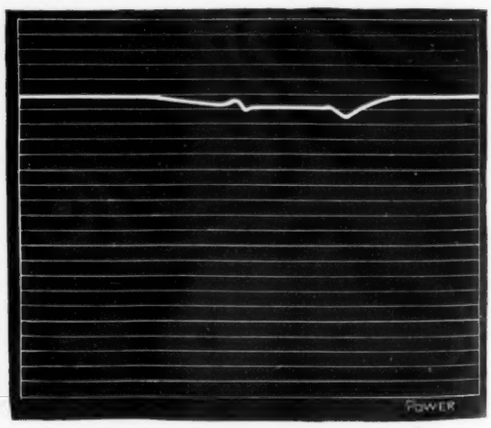


Fig. 6. Diagram with 0.6-Mm. Wire

Readings were taken with thermocouple elements of different diameters at the part exposed to the high temperatures, with a view to ascertaining which would give the best results. The results with these are shown in the following tabulation:

Diameter of Wire, Mm.	Temperature, Deg. C. Highest	Lowest
0.02	1400	142
0.025	1405	142
0.03	1410	137
0.04	1292	162
0.05	1050	307
0.1	882	475
0.2	827	585
0.4	815	695
0.6	800	775

Figs. 4 and 6 are sample diagrams, the latter with a wire of 0.6 mm. diameter, which shows an approximately straight line. The temperatures corresponding to this (see table) are above the mean, although the higher temperature influences the couple only during one stroke, while the lower covers three strokes. This nearly constant temperature with the large wire was undoubtedly due to its greater mass requiring a longer time to heat up and cool off, thus making it less sensitive to very rapid temperature changes.

Reference to the table shows that with wire thicknesses of 0.02, 0.025 and 0.03 mm., practically the same high and low temperatures were recorded, which indicates that a decrease of mass within these limits has no influence upon the sensitiveness of the instrument. Fig. 5 shows a diagram taken with the resistance pyrometer. As the ignition point is clearly indicated, the temperatures corresponding to different piston positions are easily found by drawing ordinates to correspond with the four principal events in the cycle.

Gravity Feed Semi-Stokers*

By Osborn Monnett†

SYNOPSIS—How smokeless results are obtained with this type of furnace. Directions for charging, cleaning and banking.

There is a class of equipment on the market half way between a mechanical stoker and a hand-fired furnace which can well be classed as a semi-stoker, of which there are two distinct types, the down-draft and the gravity feed. The gravity-feed furnace is essentially a dutch-oven extension built in a cast-iron frame work with an arch of firebrick and a horizontal central grate. On each side of the central grate is a short inclined grate above which are pockets for the admission of fuel. The theory of this type of furnace is to raise up the mass of fuel on the side grates with a poker or transfer bar, as the case may be, allowing the fresh fuel to gravitate behind it. Thus the fresh fuel is introduced underneath the choked portion of the fuel bed, and the volatile gases must pass through the incandescent fuel before coming out into the furnace proper. By this action it is intended to consume the volatile gases before they have an opportunity to cause smoke.

A gravity-feed furnace as applied to a horizontal tubular boiler is shown in Fig. 1. The application is simple, as it is necessary to build only a bridge-wall at the front end of the boiler, leaving a plain combustion chamber extending the full length underneath. These furnaces should always be set full extension. They can be placed in a head room of from 48 in. up, and as they operate without steam jets or stoker engines, they are equally applicable to high- or low-pressure installations.

It is a simple matter to apply the gravity-feed furnace to a water-tube boiler of the horizontally baffled type shown in Fig. 2. It gives a long flame travel and, if properly handled, allows ample time for the combustion of the volatile matter before it comes in contact with the heating surface. The furnace may be used with any type of horizontally baffled boiler, but it is not advisable to apply the gravity-feed furnace to a water-tube boiler vertically baffled as smokeless results cannot be guaranteed because of the short flame travel.

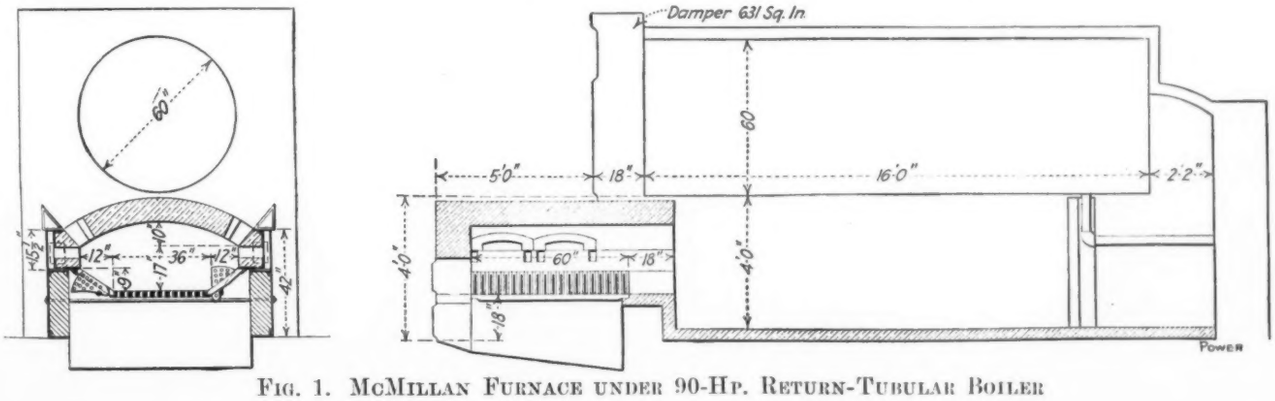


Fig. 1. McMillan Furnace under 90-Hp. Return-Tubular Boiler

With this furnace, limitations as to size come from the consideration that when the coked coal is poked off the side grates it naturally falls onto the middle one. If this middle grate is of such width that the coked coal easily covers it, then the characteristic action of the furnace will not be destroyed. If, however, the middle grate is so wide as to compel the fireman to poke green coal over to keep the grates covered, then the furnace will smoke, and it is too wide for good operating conditions. Therefore, units above 200 hp. should be used only where the conditions are carefully worked out and where it is

*Copyright, 1914, by Osborn Monnett.
†Smoke inspector, city of Chicago.

known that the highest class of operation will be had.

Fig. 3 shows a gravity-feed furnace, with a 6-ft. 3-in. extension, correctly installed under a 230-hp. Stirling boiler. The furnace proper ends at the bridge-wall and the regular Stirling arch is as in standard hand-fired practice.

Operation

In operating the gravity-feed furnace, first feed in enough coal to cover the bottom of the grate and side run the poker down the outside of the pocket to the inclined grate and down the inclined grate nearly to the bottom; then raise the poker up into the bed of fuel so that it will carry with it the coked mass of coal toward the center of the furnace. The green coal will fall behind the coked mass, and if the door is cracked, there will be no smoke. Always keep the pockets full of coal, but do not use the top of the furnace for coal storage. If the pockets are allowed to run empty so that when replenished the green coal falls on top of the fire, the fur-

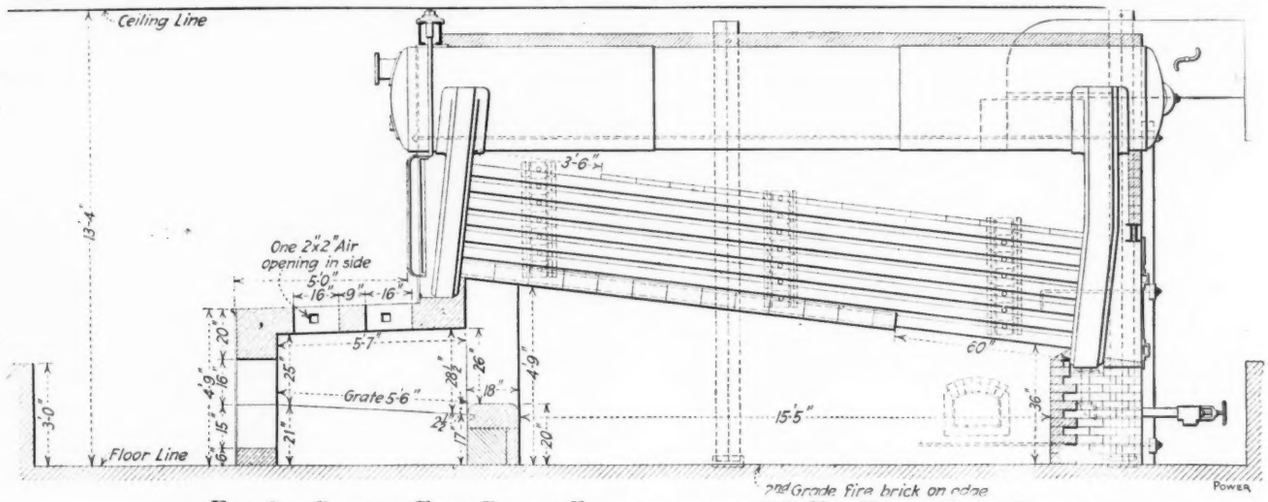


Fig. 2. Gravity-Feed Burke Furnace under 150-Hp. Water-Tube Boiler

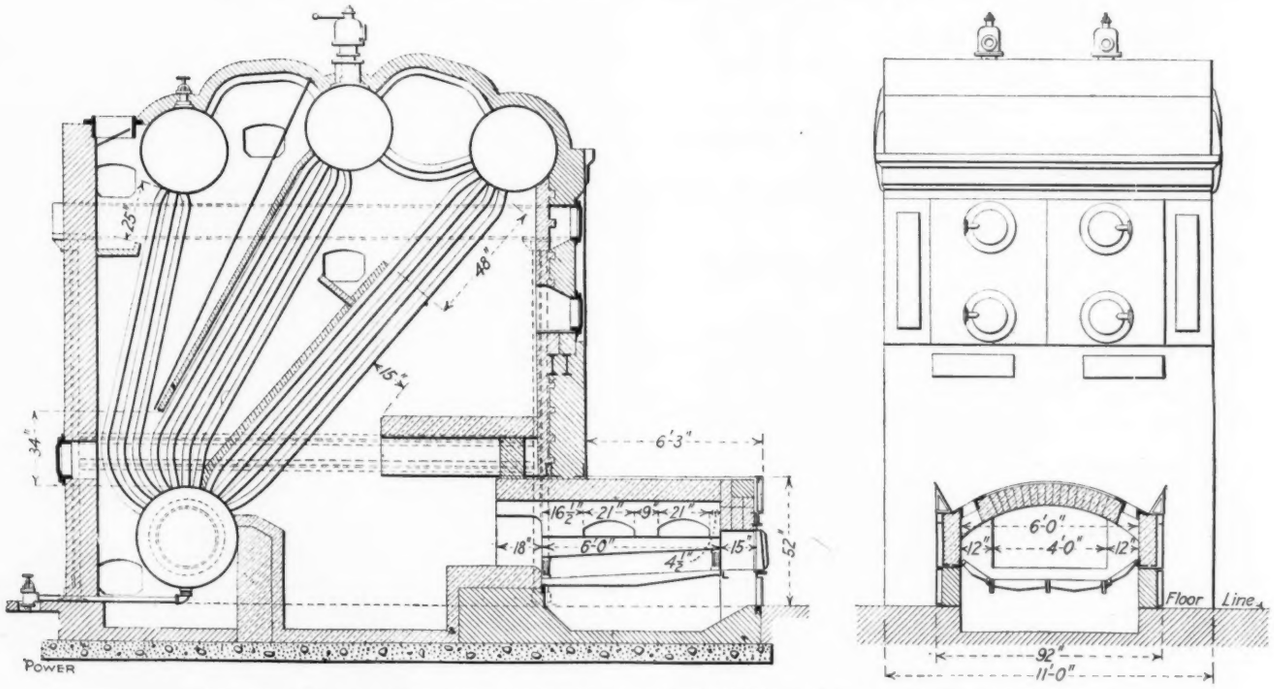


Fig. 3. Burke Furnace Installed under 230-Hp., Class A Stirling Boiler

grates. Then build a fire with kindling on top of the coal, giving the furnace plenty of air through the door, the same as with a hand-fired furnace. When the fire has ignited thoroughly and most of the volatile matter has been driven off, fill one pocket at a time, allowing an appreciable interval between the filling for the volatile matter to burn. When poking a pocket, always crack the door to take care of any excess volatile which may be distilled off. When feeding, work the coked coal carefully toward the center grate with the transfer bar or

nace will smoke. Run with the damper wide open and regulate the draft by the ashpit doors. Poke one pocket at a time and wait for the volatile to distill off before disturbing the other pocket.

Cleaning and Banking Fires

Clean out the center grate with a hoe without disturbing the side beds of fuel. Then, using the hook, clean the clinker from under the coked portion on one side of the fire, allowing the coked coal to fall down on

the center grate; in a few minutes, repeat the operation on the other side of the furnace. As these operations have to do only with coked coal, no dense smoke should be made. After spreading this coal on the center grate, leave the doors cracked and fill the pockets slowly, one at a time. When banking fires, work the coal down below the liners of the pockets and put on the covers; then close the ashpit doors and check the damper.

Sizes of Motors Driving Centrifugal Pumps

By E. M. Marshall

SYNOPSIS—The calculations necessary for determining the proper size of motor to drive a centrifugal pump under given conditions of delivery and head. By the use of the chart these calculations are simplified.

The problem of selecting the proper size of motor-driven pump and installing it to pump water a distance at the smallest cost is one that is not always given careful consideration, hence many do not operate satisfactorily, usually failing when they are most needed. While there is plenty of pump data available, as well as motor data, there is a lack of practical information on the combination. Manufacturers sell pumps to be connected to certain types of motors and when electrical troubles come up they are glad to refer them to the maker of the motor, but are little interested in securing and tabulating for future use the nature of the trouble and the remedy. Therefore, the recommendations of a pump manufacturer, without a complete and thorough knowledge of the conditions, are likely to fall short of economical operation principally because the efficiencies of ordinary pumps are low unless operated at the conditions for which they are designed.

In what follows the writer has worked up the calculations necessary for a check on a motor-driven pump installation working back from the delivery point to the pump to determine the power requirements and the proper size of motor. The calculations refer to the installation of a motor-driven centrifugal fire pump having a capacity of 750 gallons per minute. The pump was located one mile from the storage tank and the elevation from the water to be pumped to the tank was 220 ft. The pump manufacturer recommended an 8-in. line and the following formula was used to secure the power requirements.

$$\textit{brake horsepower} = C \times H \div (4000 \times E)$$

Where C is the capacity of the pump in gallons per minute, H the total head to be pumped against, and E the pump efficiency taken at 50 per cent.
Then,

$$\textit{brake horsepower} = \frac{750 \times 220}{4000 \times 0.5} = 82.5$$

This is the method commonly used by salesmen in selling pumps, and while acting in good faith they are simply applying rule-of-thumb data found in catalogs or handbooks which in every case need special interpretation and some modification and are only safe in the hands of an expert. From the calculations already given it will be seen that the value for the pump horsepower includes the suction and discharge heads but has nothing to do with the pipe friction in the 5280 ft. between the pump and the tank. It is not known how the 8-in. size of pipe for the line was arrived at; however, the following calculations will show how and where the recommendation is not practical nor economical.

The friction loss per 100 ft. of 8-in. cast-iron pipe when discharging 750 gal. of water per min. is 1.24 ft. of head; for a 10-in. pipe 0.39 ft.; and for a 12-in., 0.17 ft. The loss of head due to friction of the 5280-ft. line for the different sizes of pipe is as follows:

Size of pipe	8 in.	10 in.	12 in.
Loss of head	65.4 ft.	20.6 ft.	8.9 ft.
Saving with 10-in. and 12-in. pipes	..	44.2 ft.	55.7 ft.

The effect of the loss of head on the size of motor is as follows:

For an 8-in. line:

$$\textit{brake horsepower} = \frac{750 \times (220 + 65.4)}{4000 \times 0.50} = 107.0$$

For a 10-in. line:

$$\textit{brake horsepower} = \frac{750 \times (220 + 20.6)}{4000 \times 0.50} = 90.0$$

For a 12-in. line:

$$\textit{brake horsepower} = \frac{750 \times (220 + 8.9)}{4000 \times 0.50} = 85.0$$

From these calculations it is evident that a motor of 82.5 horsepower as calculated by the first formula and the use of an 8-in. pipe would cause the motor to carry an overload of not less than 30 per cent., and as the pump would be operated at full capacity when operated at all, such a demand on the motor could not have been performed without trouble for any length of time. Even with the 12-in. pipe line the motor would be loaded up to its capacity. In these calculations, an efficiency of 50 per cent. has been assumed which is somewhat less than can be expected of the best designs of pumps. However, this is not too great a factor of safety, as far as motor selection is concerned, for it is impossible to secure commercial sizes of motors that correspond exactly to the calculations made. For instance, as shown above for the different sizes of pipe line, a 100-horsepower motor will be required for the 8-in. line, and the 10-in. line and a 75-horsepower for the 12-in. line, which will just about place the pumps on a 60 per cent. efficiency basis.

As to whether or not the additional cost of pipe for the larger sizes will be economical as to operation, the following calculations show:

Cost of 75-hp. motor for 12-in. line	$514
Cost of 100-hp. motor for 8-in. line	654
Cost of pipe f.o.b. factory at $20 per ton:	
8-in. cast pipe at 48 lb. per ft. or 127 tons	2540
12-in. cast pipe at 82 lb. per ft. or 216 tons	4320

The cost of motor operation at 2c. per kilowatt-hour is as follows:

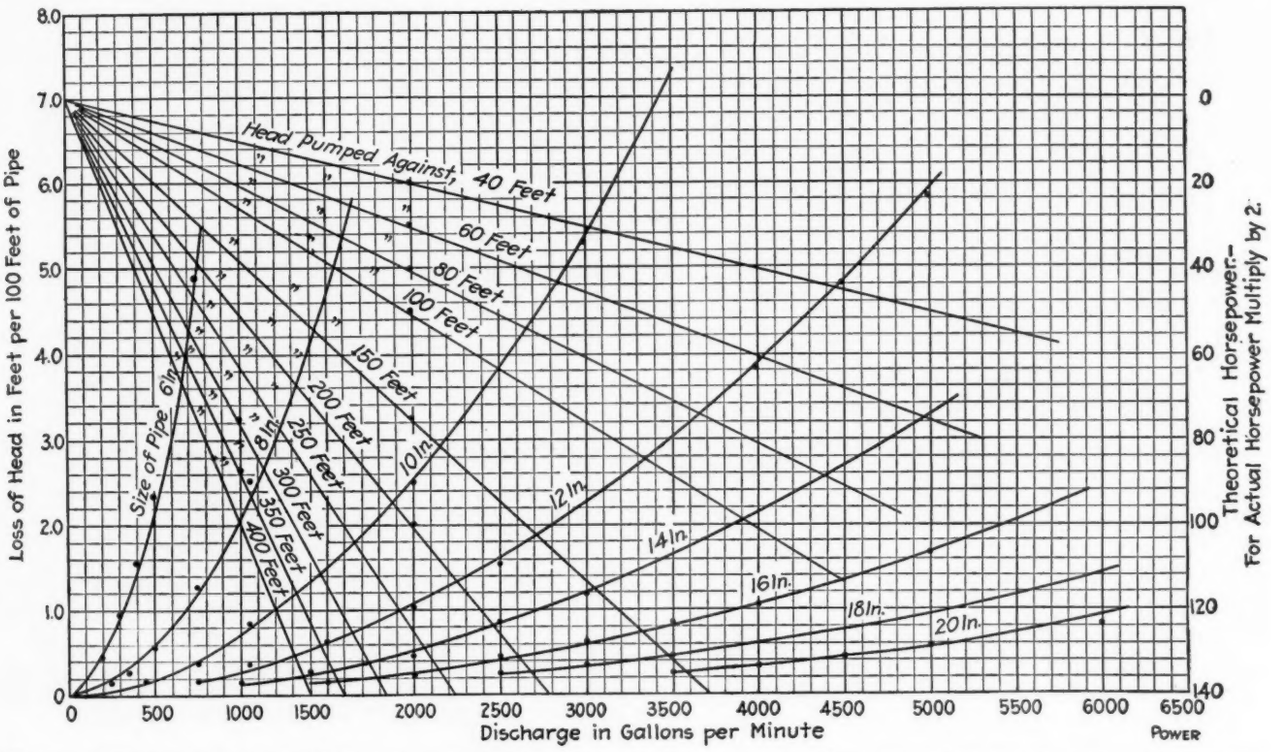
For a 100-hp. motor:

$$\frac{100 \times 746 \times 0.02}{1000} = \$1.49 \textit{ per hour}$$

For a 75-hp. motor:

$$\frac{75 \times 746 \times 0.02}{1000} = \$1.12 \textit{ per hour}$$

The demand on the pump was 250,000 gallons per day, which required it to operate



CURVES, SHOWING LOSS OF HEAD DUE TO FRICTION OF STRAIGHT AND SMOOTH CAST-IRON PIPE; ALSO THEORETICAL HORSEPOWER FOR DRIVING PUMPS

on the bottom of the curve sheet run up vertically to the straight line showing 250 ft. head and then directly across to the right reading about 46 horsepower, or the theoretical power required. This figure does not take into account the efficiency of the pump which can be safely taken as 50 per cent. Then to get the actual size of motor, the horsepower as shown, namely 46, must be divided by 0.5, giving 92 as the horsepower required.

$$\frac{250{,}000}{750 \times 60} = 5.5 \textit{ hours per day}$$

Then the annual cost of pumping is:

For a 75-hp. motor = 5.5 × 365 × $1.12 =	$2248
For a 100-hp.-motor = 5.5 × 365 × 1.49 =	2936
Yearly difference in cost of operation..	$688
The extra cost of the 12-in. pipe (4320 — 2540) =	$1780
Saving in cost of the motor in favor of the 12-in. pipe =	$140
Extra cost of pipe less saving on motor.....	$1640
Five years' saving in cost of motor operation.....	3440
Five years' interest at 6 per cent. on extra investment plus the investment.....	2132
Total saving in five years in favor of 12-in. pipe..	$1308

Besides this saving, better operation is secured with less trouble and fewer interruptions, worth perhaps in case of fire, many times this amount.

Many of the calculations given in the foregoing discussion can be avoided by use of the curves in the accompanying chart showing loss of head in feet due to friction for straight, smooth cast-iron pipe and the theoretical horsepower required to drive pumps. To use this set of curves proceed as follows: Suppose it is required to know the size of motor to pump 750 gallons of water per minute using a 10-in. pipe and pumping 5280 ft. against 220-ft. head. Finding 750 on the horizontal line of the curve as the discharge per minute, follow vertically to the curve for 10-in. pipe and read a loss of head of nearly 0.4 ft. per 100 ft. of line. Since the length of line is 5280 ft. the total loss of head is then 0.4 × 5280 ÷ 100 = 21 ft. Adding this to 220 ft. of vertical head, the total head to be pumped against is then 220 + 21 = 241 ft. Again finding 750 gallons per minute discharge

An Omission

Owing to an oversight the accompanying table was omitted from the article entitled "Department No. 8 and Special Furnaces," by Osborn Monnett, on page 166 of the August 4, 1914 issue.

DIMENSIONS FOR FIG. 1

(All Dimensions in Inches except Column B which is in Feet)

A	B	C	D	E	F	G	H	I	J	K	L	M
42	12	28	19	42	42	22	16	3½	16½	18	9	8
42	14	28	19	48	42	22	16	4	15	18	9	8
48	12	30	20	42	48	24	18	3½	18	18	9	8
48	14	30	20	48	48	24	18	4	16½	18	9	8
48	16	30	20	54	48	24	18	4½	15	18	9	8
54	14	32	22	48	54	24	18	4	16½	18	13½	8
54	16	32	22	54	54	24	18	4½	15½	18	13½	8
60	16	34	22	60	60	26	18	5	17	22½	13½	8
60	18	34	22	66	60	26	18	5½	15½	22½	13½	8
66	16	34	24	60	66	28	18	5	18½	22½	13½	8
66	18	34	24	66	66	28	18	5½	17	22½	13½	8
72	16	36	24	66	72	30	20	5½	18½	22½	13½	8
72	18	36	24	72	72	30	20	6	17½	22½	13½	8
78	18	38	26	72	78	32	21	6	19	26	18	8
78	20	38	26	78	78	32	21	6½	17½	26	18	8
84	18	38	26	72	84	32	21	6	20	26	18	8
84	20	38	26	78	84	32	21	6½	18½	26	18	8

Note:—Dimensions in the above table apply only for the ordinary conditions and are subject to revision for unusual conditions.

Note:—First grade fire brick to be used throughout with the exception of the combustion chamber floor and the side walls of the chamber back from a point one ft. behind the rear face of the wing-walls. Wing-walls to be bonded into side walls. No air space to be left in setting walls. Fire doors must provide for special air admission of an area equal to 4 sq.in. for each sq.ft. of grate surface.

Missouri Coal Production in 1913—The production of coal in Missouri in 1913 was 4,318,125 short tons, valued at $7,468,308, a decrease compared with 1912 of 20,731 tons in quantity and of $165,556 in value. With the exception of 1912, however, the output in 1913 was the largest in the history of the state.

Editorials

Does "Safety First" Legislation Handicap the Steam Plant?

A gasoline-engine advertisement in a popular magazine recounts the experience of a contractor who had successfully used the engine advertised upon some contracting work.

First he used steam. But steam meant a licensed engineer and fireman. It wasn't sufficiently portable and elastic. He had to keep several types of boilers to conform with different state and city ordinances.

Whereat numerous engineers and sundry manufacturers of boilers, engines and steam apparatus think they see a big beam of light. All this Safety First Legislation requiring a man who sets up a boiler in a crowded district to put a competent and reliable man in charge of it, requiring a boiler to be correctly designed and honestly built of suitable material, forbidding the pollution of the air in which thousands must live, by unnecessary fumes and smoke, all this beneficent legislation which other countries have adopted with a signal decrease of the loss of life and property and a marked betterment of the conditions in industrial neighborhoods must be opposed and rescinded or the internal-combustion engine and central station will take advantage of the hardships which it imposes to put us out of business.

How much of a hardship would it be for a contractor or other employer to hire a licensed engineer or fireman. He might have to pay a lesser daily wage to a laborer who could not satisfy an inspector that he was a safe and competent man for the place (and that is all that an inspector can require of a man), but if everybody had to hire licensed men he would be at no competitive disadvantage as between certified and uncertified labor, and as for skill, we have never found that less skill was required to run an internal-combustion than a steam engine. Insurance and fire-department regulations regarding the storage of oil and gasoline are likely to prove more onerous, within centers of population, than the legislation referred to.

The disadvantage which arises from lack of uniformity in the boiler laws of various states and cities is a real one, not only to the user but to the maker of boilers. He cannot make boilers up for stock and is obliged to carry all kinds of material or to buy in small lots for each order. This does not mean that the interests of the boiler manufacturers can be best served by discouraging the passing of any more such laws and the enforcement of those already on the books. Their real interest lies in having uniform laws which unify and standardize the work and material and put the man who gets the contract by skimping the material and slighting the work out of the running.

The best interest of good engineers and good boiler makers lies in forwarding, not in opposing the proposed uniform legislation for the inspection of boilers and the examination and licensing of engineers.

Avoiding Irregularities in Station Design

To many engineers the design of a generating station on the so called unit system appears cut and dried practice. Doubtless systematization can be carried too far in the treatment of engineering questions bearing upon power development, but experience shows that departures from uniformity in equipment arrangement sometimes lead to troublesome complications, particularly where such changes from regularity are made to reduce first cost. Thus, in a hydro-electric station of four units, the exciter turbines were arranged to receive their water-supply from the penstock of one unit, the other three penstocks being connected to their respective wheels without any auxiliary piping. In each penstock a Venturi meter recorded the flow of water in the usual way.

Since the meter in one penstock recorded the flow through the corresponding generating unit and the exciter turbine carrying the plant at any particular time, it was impracticable accurately to determine the rate of flow through the main turbine. To estimate this it was necessary to operate two turbines and their generators at as nearly equal load as possible, one of the penstocks supplying the exciter turbine, which ran at practically constant gate opening. Curves were plotted in millions of gallons per 24 hr. as ordinates and gate openings as abscissas, and it was assumed that since these turbine units were of the same rating and design, the difference in ordinates of these curves for a particular gate opening would give the rate of flow through the exciter. It was not found feasible to check this method closer than 300,000 gal. in 24 hr., but this was within 4 per cent. of the total water consumption of the exciter turbines.

This approximate method of determining the water consumption of the turbine whose penstock also supplied the exciter would not have been necessary had the unit plan of station design been followed in which each exciter wheel has its own independent pipe connection with the forebay. The first cost probably would have been increased somewhat, but not enough to overcome the advantage of being able to read the water consumption rate and total flow with 98 per cent. accuracy from, say, half load to about 25 per cent. overload on each of the main turbines.

More and more the accurate measurement of water in hydro-electric stations is receiving the deserved attention of engineers; in many cases it is as important as the measurement of fuel in steam plants, and where meters such as the Venturi are installed to check the performance of the various station units and to forestall falling off in operating efficiency or to control more closely the reservoir and discharge conditions, it is a pity not to make the best possible installation of equipment on the station-unit principle and thus obtain the best results of a far-sighted investment.

Neatness

The owner of a fairly prosperous shop was asked not long ago why he did not keep things picked up and swept up better. His reply was that if he did his customers would think he had nothing else to do and would take their work elsewhere. Wh th r this is false philosophy or not, it is a fact that an engine room is apt to be the most presentable part of a manufacturing plant. As an index of good management it is the exact opposite of the idea expressed by this particular shop owner. The less an engineer has to do the greater his value. If he is continually fixing up leaky couplings and packing piston rods, it is an indication that he is doing something that he should have done some time before or else that he tries to economize on cheap packing that is not worth using.

An engineer who has a Corliss compound in a nice light room with rubber matting all around and a handsome switchboard to show his friends feels compelled to keep his plant in nicer shape than his wife does her parlor. The other poor fellow who finds a broken down cripple of a slide-valve engine in a dark corner fenced off from the rest of the shop by nothing more substantial than a pile of scrap castings, has a right to an attack of the blues. He thinks he is not likely to be found there by someone who wants a man in one of the nice plants and he is apt to let things go as he finds them and trust to luck to find a better job. That is where he is mistaken. A neat, clean engine, running smoothly and keeping at it every day will attract more attention among such surroundings than it will where such things are expected. There may not be many mill or shop owners coming around to visit the plant, but salesmen whose business it is to know every plant will come and they can do nothing better for themselves than to tip off an owner as to where a g od engineer is to be found. One can never go far enough off to get out of sight and hearing of men who might be friends.

An engineer who keeps things clean and does nothing else is a faker and no more. Neatness must be a by-product of ability or it is worthless.

Attention of Firemen

Considerable space in POWER is devoted to advice to engineers to improve their condition and qualify for higher salaries, shorter hours of labor, etc. This advice is good and should be appreciated, but how about the fireman?

Seldom is any disposition shown by the men who are employed in the fireroom to study to improve their condition, or to follow instructions when the work or methods were not entirely in accord with their hard and set way of firing. Still, you will hear them complain about the hard work, the small pay and the long hours. The fireman will tell you very quickly how many pounds of coal he wheeled in and burned under the boilers, how many barrows of clinkers and ashes he wheeled out during his watch. He will tell you all this in a way to impress you with his ability to burn coal and clean fires, but did you ever hear one say anything about how much water he evaporated per pound of coal during his watch, or that he found that, with the especial grade of coal he was burning, a fire maintained at a certain thickness gave the best results, or that he was able to maintain constant steam pressure by watching his water gage, or better results were obtained by him because, instead of filling the furnace with coal clear up to the door and sitting down and waiting for it to burn, he puts the coal in in small quantities and as regularly as required, keeping the furnace door closed as much as possible, and only by systematic firing can this be done.

The fireman, as a rule, is a hard-worked man and most fire rooms are not very pleasant. They are hot and dusty, accommodations for washing and toilets are poor and frequently the fireman has to go home dirty, which does not cause him to like his job any too well. The average fireman does not realize the important position he fills in the plant. Generally he is in charge of boilers located in buildings costing thousands of dollars, in which are employed a large number of people. Unless he is alert and onto the job, damage might be done, or the works closed down for want of proper and efficient attention to duty.

Better conditions would exist if there were more cooperation between the engineer and fireman. The fireman should improve himself by studying conditions of the boilers and furnaces he is working in order to improve and demonstrate his ability to his employer and show that his aim is to get all that is possible out of his plant at the least possible cost by constant attention to every detail where waste might exist. The employer, on the other hand, should study the comfort of the fireman and give him decent and proper facilities so that he may go home clean. He should show that he is interested in him and that he expects the fireman to study his interest in return. As soon as the employer realizes that, to economically operate his plant, he must look to the interest of his men, and the employee in the fireroom realizes that to better his condition he must improve by close application to study in his chosen line and by giving his employer the best there is in him, the better it will be for both.

Bumped Heads

POWER has been charged with putting undue stress upon the liability of bumped heads of large size to fail from the effect of repeated flexure about the line where the radius of curvature changes. Since our warning was sounded another disastrous explosion has happened from this cause and the Massachusetts Board of Boiler Rules proposes to stiffen up its requirements with regard to bumped heads by increasing the factor in its formula from 5 to 8½ and making the radius of the short curve three or four times the thickness of the material. The British Board of Trade restricts the use of bumped heads to drums of 48 inches and under.

If you do not record the coal consumption and energy output, you can never know how much steam can leak through a small hole.

Latest bulletin of the Mellon Institute says Pittsburgh should be the greatest center in the world for combustion engineers. But who wants to assume responsibility for the job of making Pittsburgh smokeless?

Correspondence

Portable Draft Gage

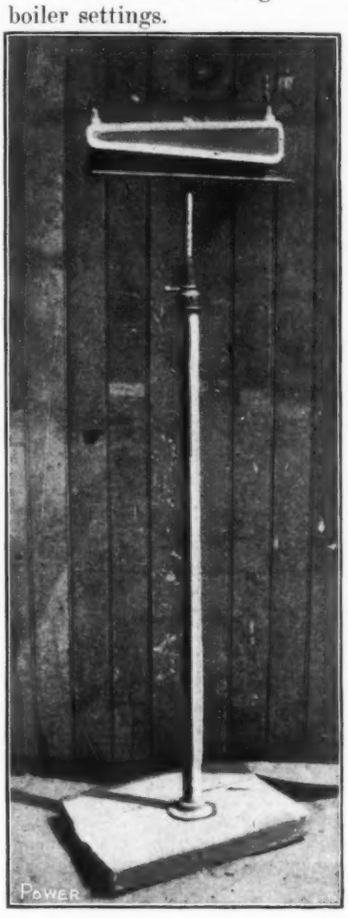
This draft-gage support is useful when taking readings at different points in boiler settings.

The base is of 2-in. board about a foot square, to which is fastened a floor flange screwed on a 1-in. pipe some 4 ft. long. A 1x½-in. reducing coupling is reamed out to allow a ½-in. pipe to slip through it and is drilled and tapped for a setscrew, as shown.

A ½-in. pipe 3 ft. long is flattened for 6 in. and drilled to receive two bolts which hold a 2-in. angle-iron leveling support. The flattened pipe extends high enough above the angle iron to receive the bolt which holds the draft gage in place. There is a setscrew at each end of the angle iron for leveling the draft gage. By means of these adjustments the instrument may be set and leveled quickly.

CECIL CAHERT.

Columbus, Ohio.



GAGE STAND

Operating Underfeed Stokers

J. C. Hawkins' difficulties due to the formation of clinkers on the side walls of boiler furnaces and the various methods he has employed to prevent this clinkering are interesting, yet it is hardly surprising that he was not entirely successful in his efforts. In the first place, none of the bricks or other materials suitable for boiler-furnace construction will prevent the adherence and building up of clinkers. Furthermore, his efforts were not directed against the formation of clinker, but rather against its sticking to the brickwork.

A very simple remedy for troubles of this kind is the use of steam jets. These jets should be so located that they will play upon the side walls where the clinker formation occurs. Only a small amount of steam is required and the apparatus for applying it is quite simple.

A piece of ½- or ⅝-in. pipe having a longitudinal row of small orifices and applied to each side wall, on the inside, of course, will do. This pipe may be easily inserted through the furnace front and fastened to the side wall. The inserted end should be capped, whereas the other end may be connected either with the steam line or to the boiler itself, as may be most convenient. The length of the pipe is governed by local conditions; that is, by the length of clinker formation on the walls.

It is rather amusing to note Mr. Hawkins' comments on the smoke question and his way of keeping within the law. The emission of smoke from a stack at night is just as much an infraction of the law as during the day. Mr. Hawkins merely takes advantage of the smoke inspector's inability to catch him at it. A better result, so far as the smoke problems is concerned, might be obtained if the fires are cleaned oftener, so that they will not get into bad condition. Moreover, there should be no necessity for "barring" a fire when an underfeed stoker is used, and this practice can be almost entirely eliminated by exercising care and watchfulness. It seems to be a difficult matter to prevent firemen from "working" the fires unnecessarily. There must be some fascination about it.

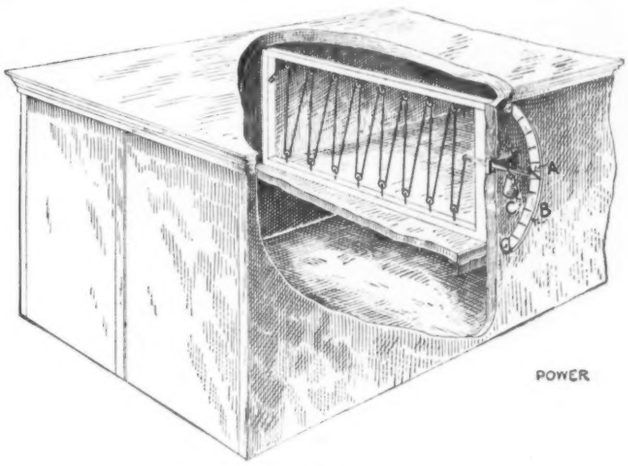
EVERARD BROWN.

Pittsburgh, Penn.

Hygrometer Actuated by Hemp Cord

Having experienced much difficulty with the various types of hygrometers, I made the instrument shown in the illustration.

In the center of the sheet-iron box a frame was fitted up with eight 1-inch pulleys on top and bottom. Through these was drawn a cord. As hemp cord shortens when



HEMPCORD HYGROMETER

damp and lengthens in drying, this means was used to work the arm of the indicator *A*. This operates in a semi-circular form upon the arch *B*, graduated as shown; the weight *C* gives tension to the line on the pulleys.

The movement of indicator *A* accurately shows the state of the air from very wet running downward to very dry.

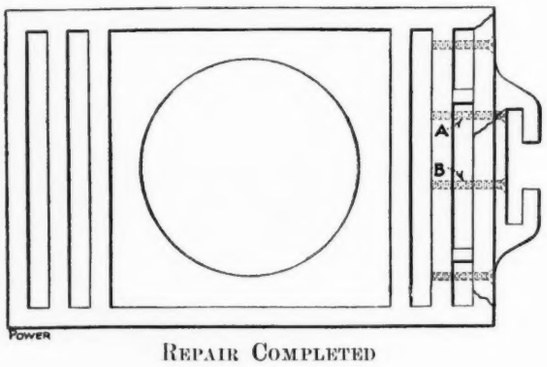
J. A. LUCAS.

New York City.

Repairing a Broken Slide Valve

Speed is the principal factor in emergency cases and every minute saved on a break-down job means dollars to the owner. The valve of a 100-hp. engine came into the shop broken as shown. This accident caused a large plant to shut down until a rush repair job could carry it on temporarily and a new valve could be put in.

On being turned over to the repair man, he said that the valve would be ready for use in a short time. He was laughed at, but told to go ahead.



REPAIR COMPLETED

The valve was put on a surface plate and the broken pieces carefully clamped in place and drilled. Machine screws were put in as shown, using spacers at *A* and *B*, thus making the valve as serviceable as it was originally. The repair was finished in about one-half the time it was expected to take.

FRED E. LAIRD.

Yonkers, N. Y.

Improving a Vacuum Heating System

A vacuum heating system is undoubtedly a fine thing when properly installed and operated, or it may be a source of great annoyance to an operating engineer. The plant in which I am employed is considered the finest for its size in the Northwest. It has a vacuum heating system as part of its equipment.

On going over the plant for the first time, I found that the vacuum pump, instead of moving at a slow, steady gait, was making about 80 strokes per minute. The night engineer remarked that the previous chief examined the valves about once each week, but never could overcome its nervousness.

The next day I gave the water end a thorough overhauling; the valves were in good condition, but the water piston was minus even the slightest hint of packing. This being remedied, the pump settled down to work in a normal manner. This was during moderate weather and with atmospheric pressure on the heating system. When cold weather came and we had a 4-in. vacuum on the system, the pump suffered a relapse. Inspection of the valves and packing failed to show the cause.

Upon looking over the piping, I found that the pump discharged into an overhead tank which was vented to the atmosphere. From this tank the returns flowed to the open heater through a 4-in. line. As the return water was insufficient to keep the line to the heater sealed for the greater part of the time, the air thereby admitted to the heater had to be handled by the pump. The defect was overcome by putting a 6-ft. water seal in the line from the tank to the heater, and there was a marked reduction in speed.

However, there still seemed room for improvement, and my suspicion fell on the line which trapped the oil separator. This line, on being disconnected on the discharge side of the trap, proved the suspicion was well founded. There would be a suction of air into the line for perhaps a minute, and then a long discharge of a full stream of oily water. A water seal was also inserted in this line, the trap removed and the line left open for a few days to watch the result. After blowing down the boilers, a full-sized stream of muddy water issued from this pipe, and there was revealed another peculiar condition.

The blowoff line leads into a blowoff tank and the drain line from the back pressure valve discharges into the same tank. Blowoff water from the boiler had backed up this drain line into the exhaust line and had flowed back until the separator had caught it and shot it through the separator drain. It was easy to see that air could enter where water could go when there was a 4-in. vacuum to entice it. So a check valve was placed in the drain line of the back pressure valve and at last the pump got down to something like normal speed.

E. S. FITZ.

St. Paul, Minn.

Cost of Operating a Vacuum Ash-Handling System*

Mr. Sandstrom obviously refers to that type of conveyor in which a current of air is maintained by a compressor, positive blower or fan. His figures seem to be deduced from experience with one conveyor only, and improperly designed, as is indicated by the unnecessarily large motor, the excessive wear, and the fact that the conveyor was, as he says, abandoned. Scores of conveyors of this general type are in use, and only a few of the earlier installations have not proved economically efficient. A comparative survey of the field, noting the character of the plants in which these conveyors are successfully operated and the names of the engineers who have repeatedly specified them, would prove that the failure mentioned by Mr. Sandstrom is the exception rather than the rule.

The figures of operation cost as deduced are fairly close to the actual cost, the errors tending to balance one another. The items are discussed under the heads of power, labor, interest and depreciation. I criticize them as follows: A conveyor having 7 tons capacity per hour would require a motor of from 15 to 30 hp., never exceeding the latter unless of great length or having an unusual number of turns. The cost of electrical power varies with the locality and the conditions, but 5c. per ton is a fair average figure.

One man can easily feed 7 tons of ashes an hour to a conveyor under ordinary conditions. In many cases, the hoppers are under the stoker hoppers, thus minimizing this labor. In most plants as small as the one under consideration, no extra labor is required as the regular fireman feeds the ashes to the conveyor, working a few minutes at a time at intervals during the day. One-half of Mr. Sandstrom's figure, or 2.8c. per ton, is ample.

*See also April 7, July 7, Sept. 8, 1914, issues.

In estimating the cost of complete installation, Mr. Sandstrom omits the motor and exhauster, which is more than fair to the conveyor manufacturer. A conveyor for such a plant as he describes would cost not less than $3500, and with a large tank, under some conditions, might reach $4500, including trenches, floor, plates, etc. Assuming as an average $4000, the interest amounts to 7.6c. per ton.

Depreciation is the cost item which depends most largely upon the proper design, care and operation of a conveyor. Mr. Sandstrom's figure shows a depreciation of $400 per annum in the plant. I am familiar with a conveyor, built about eight years ago, where the repairs cost less than $15 per year. The motor is 25 hp. and the amount of ashes handled considerably exceeds 8.64 tons per day. The tank, although unlined, has never been repaired, but is painted occasionally.

Another conveyor, in operation over four years, removes the ashes from ten 500-hp. boilers; it has a 30-hp. motor. The repairs, according to the user, have cost considerably less than $25 per annum. The conveyor has never been out of commission, and the engineer has since specified another conveyor which has been installed and is operating successfully.

A large conveyor, of 18 tons capacity per hour, has been in operation for more than four years, handling from 40 to 50 tons per day at an annual cost for repairs of less than $50. This shows a cost under ½c. per ton of ashes handled.

A study of the records of a large number of plants shows that repairs vary from $10 to $300 per annum; cost of plants, from $3500 to $10,000; ashes handled per year, from 3000 to 20,000 tons. It is interesting to note that the highest repairs cost is frequently in smaller plants, probably because, where the amount of ashes is large, the removal is of sufficient importance to secure supervision of the conveyor.

In arriving at the cost of repairs, records from many plants show that $150 per annum is more than liberal for a plant of the size and capacity mentioned by Mr. Sandstrom. This amounts to 4.7c. per ton handled. The total cost as taken from the records of many plants, is as follows: Power, 5c.; interest, 7.6c.; labor, 2.8c.; depreciation, 4.7c.; cost per ton, 20.1c.

It is not my purpose to establish a fixed price per ton for ashes handled, as this will vary through wide limits with varying conditions. A cost of 25c. per ton for taking ashes hot from the pits and placing them quenched in cars or carts outside the boiler room is not excessive where the total amount is small. Anyone who thinks he does it for less by the use of wheelbarrows, industrial cars, skip hoists or mechanical conveyors, probably does not include all the items which enter into the cost.

W. W. Ricker.

New York, N. Y.

Comparing Plant Efficiencies

As I have long recognized the fallacy of speaking of fuel in terms of weight and also comparing plants on a basis of pounds of coal per kilowatt-hour generated, I was much pleased with the article by Mr. Smith in the Aug. 11 issue on "Comparing Power Plant Efficiencies."

Our coal is a low-grade bituminous, mined from a seam about 4 ft. thick. The mine and also the power plant are municipally owned and operated, Lethbridge being the only city in western Canada owning and operating a civic mine. It is situated about 2000 ft. from the plant, the coal being hauled in small cars and dumped into a receiving hopper, thence through a crusher and conveyor to the bunkers, and from there it is fed through spouts to the chain-grate stokers. The proximate analysis is as follows:

Moisture	6.55%
Volatile	39.32%
Fixed Carbon	32.98%
Ash	21.15%
Sulphur	1.21%
B.t.u.	9718

The coal as fired is run-of-mine, which accounts for the large percentage of ash, and is about the same grade as the "Illinois" coal used in plant No. 3 in the article mentioned. It is interesting to compare our average for seven months with their average for six months.

LETHBRIDGE PLANT

B.t.u.	Kw.-Hr.	Lb. Coal per Kw.-Hr.	B.t.u. per Kw.-Hr.	Kw.-Hr. per Million B.t.u.
9718	283,585	5.34	51,115	19.76
		PLANT NO. 3		
9639	991,780	5.42	52,242	19.125

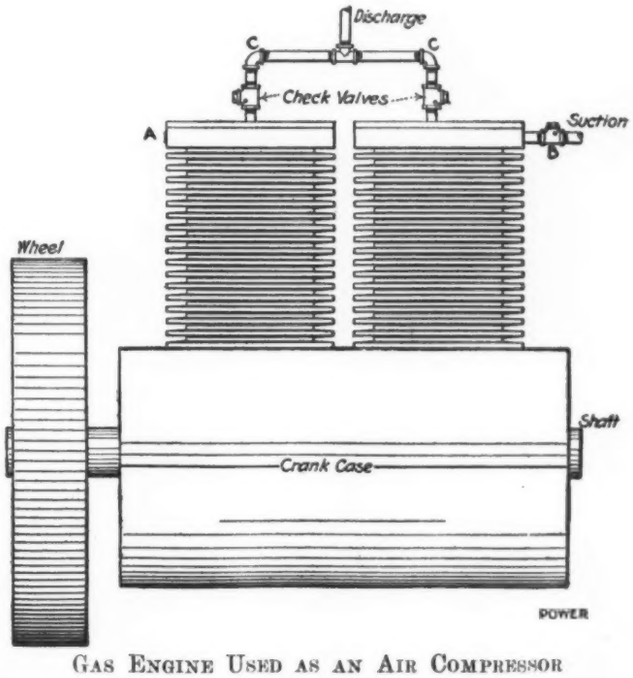
For an installation with an output of approximately one-third that of plant No. 3, this is a fairly good showing.

Arthur Reid,
Commissioner Public Utilities.

Lethbridge, Can.

Air Compressor Made from a Gas Engine

In our plant a recent change made it necessary to have compressed air at a pressure of 40 lb. or more. As it was something of an experiment, I could not recommend purchasing a new air compressor, so I decided to make a compressor out of an old two-cylinder, air-cooled, marine-type gas engine which was not to be used as an engine again.



Gas Engine Used as an Air Compressor

This engine had a closed crank case and a wheel on one end of the shaft. The spark plugs being set in as at *A*, it was only necessary to ream out and tap these holes to ¾ in. Into these holes I screwed a close nipple with a check valve, as at *B*, for the suction valves.

The head plates were drilled and tapped for half-inch nipples having check valves for discharge valves. The two checks in the heads were then piped together and the compressor was ready to run. It has operated with excellent results, carrying 50 to 80 lb. pressure, nine hours per day at a speed of 90 r.p.m. The total cost of the change was about $6.

A. D. Palmer.

Dorchester, Mass.

Explosion in Air Compressor

On page 72, July 14, Mr. Oerlichs does not state the air pressure used. If it is high, say, 150 lb., or even 100, his trouble should not have been unexpected from the amount of oil used. At present, I have no air compressors, but I intend to try lubricating with a mixture of soapy water and graphite, fed by a pump lubricator fitted with a check valve having a spring of sufficient strength to prevent the compressor suction from drawing in the mixture. Of course, lubricating with such a mixture will necessitate cleaning out the receiver occasionally, but it will certainly remove the danger of an explosion.

E. R. Pearce.

Rochdale, England.

Result of Taking Chances

On Saturday, July 11, a boiler accident occurred at the Taugh Oakes mine, Swastaka, as a result of which one man was killed and another badly scalded. It appears that the outside source of electric power was cut off, and the mine started up its own steam plant. Some of the tubes were leaking so repairs were begun. Finally there was one tube short of enough to finish the replacements, so a through rod was put in with two ordinary cast-iron washers with gaskets on the tube plates, the nuts were tightened up and steam raised to 120 lb. pressure. Soon after, the joint in the firebox began to leak badly and the master mechanic went to the smoke box end, to tighten up on the rod, when the nut on the firebox end stripped with the disastrous results as stated.

It seems strange that men will take such chances with pressure like that after so many accidents have happened in the past. The tube will have to be put in after the accident, why not before?

J. B. Hilliard.

Haileyburg, Ont., Canada.

Machinery Designing vs. Repairing Facilities

My experience corroborates that of Edwin W. Creed, on page 64, July 14. I am running an engine the main body of which is cast to form a hood over the stuffing-box and forward so far that it is a long reach to get at the stuffing-box; the ends of the guide bars extend to within ⅝ in. of the gland bolts. The piston rod cannot be packed when the engine is hot, and after the nuts are taken off the gland must be pulled back and turned quarter way around to get it back between the guides; the packing must be put in and the gland and nuts put back with one hand, as there is not enough room to get both hands in.

In order to adjust the bottom guide bars, the connecting-rod must be disconnected at both ends, the piston rod taken out of the crosshead, the top guide bars taken off and the crosshead lifted out. It now takes two men one day to do the job, whereas one man could do it in half an hour if the engine were properly designed. If the crosshead brasses must be examined, disconnect the crank end of the rod and turn it straight up; take out the two bolts and the key holding the strap, and take out the brasses; reverse this order to get them all back again.

If I had been in Mr. Creed's place, I would have held up the job and insisted that the piping be done correctly.

A. A. Blanchard.

Oxford, N. J.

Graphite in a Mine Boiler

One boiler was a water-tube of 125 hp. and the other a tubular of about 100 hp.; both were using mine water and had at least ¼ in. of scale on the inside of the tubes and on the sheets in the drums. In some places the scale was ⅜ in. thick.

I decided to try graphite, but was doubtful of results: we put it in freely with the feed water. I opened the boilers at the end of one week, and although the graphite had no apparent effect, we still kept on using it. I opened the boilers again in 30 days and found that the scale was cracking off in places. At the end of two months our boilers were cleaner than they had been in ten years, and I believe at present they are practically free from scale.

We took scale out of the drums in sheets, some as large as 18 in. square. I found that the scale did not drop off much of its own accord except in the tubes, but as soon as it was struck with the scaling hammer it came off in large pieces.

A. S. Tidman.

Yonkers, N. Y.

Quick-Closing Throttles

Reading the account of an accident to a compressor on page 112, July 21, makes me wonder why engineers persist in putting the wheels of throttle valves directly in line with flywheels, and why a quick-closing throttle is not used. Double butterfly valves are a success as throttles on marine engines against any pressure, and they work easily. In this case, it is reported that the valve turned hard; I presume that it would take at least 12 turns to close it.

By using quick-closing throttles on all engines so located that they can be handled without the operator standing in line with a flywheel, many bad accidents could be avoided.

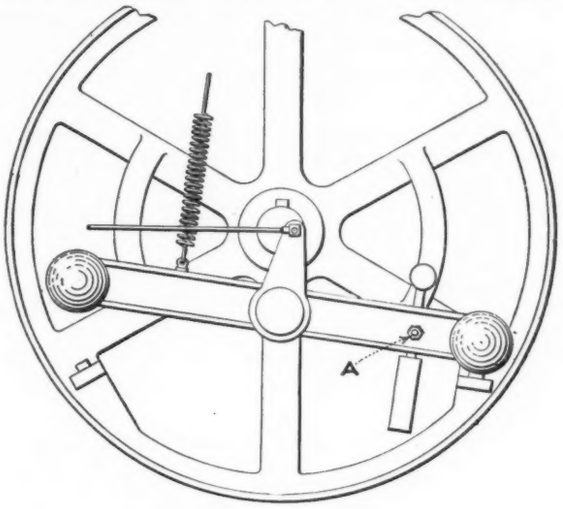
One way of lubricating a hard-closing throttle is to introduce the cylinder lubrication above it. In this way the oil will come in contact with the packing and keep it soft for a much longer time.

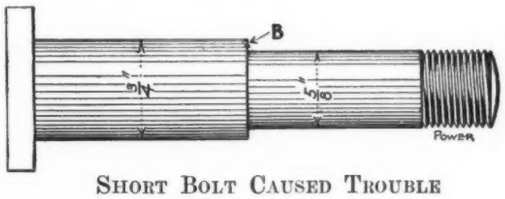
David A. Humphrey.

Detroit, Mich.

Trouble with Inertia Governor

Upon taking charge of a plant, I found the governor on a 16x16-in. engine extremely sluggish. The trouble was finally located in the dashpot lever bolt *A*. The large part





SHORT BOLT CAUSED TROUBLE

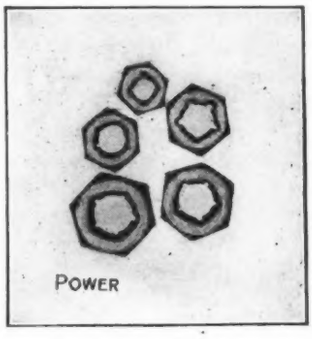
B of the bolt was not long enough by ⅛ of an inch, causing the lever to bind on the inertia bar. A new bolt restored the governor to its original sensitiveness.

E. A. TICHENOR.

Beechwood, W. Va.

Dies Made of Steel Nuts

A set of dies made of steel nuts will be found almost invaluable in the plant. They are especially useful in clearing the threads on stud bolts, in place, when the studs are too close together to use an ordinary die stock. In the absence of some such means of improving the thread, the stud must be taken out and threaded in a vise, or, more likely, the nut will be forced on and the stud broken before the joint is made up or insufficient pressure is put on the gasket; then the joint will be lost. With the die nuts the studs can be left in place and any obstruction cut away by running the die nut down on the thread and off again.



SET OF DIES

The danger of broken studs is greatly reduced when the threads are clear, as the tensile strength is easily sufficient to hold a joint, but the torsional strength is so much lower that the stud may be easily twisted off. The labor involved in drilling out one broken stud will often equal that of making a complete set of die nuts as shown. They are made by taking steel nuts and inserting loosely fitting studs and drilling four or five small holes between the nut and stud. If the stud fails to unscrew freely, drill its center so as to release the threads. The cutting edges of the drilled holes should then be trued with a file and the nut hardened to suit the kind of work, and the job is complete.

JOHN POWERS.

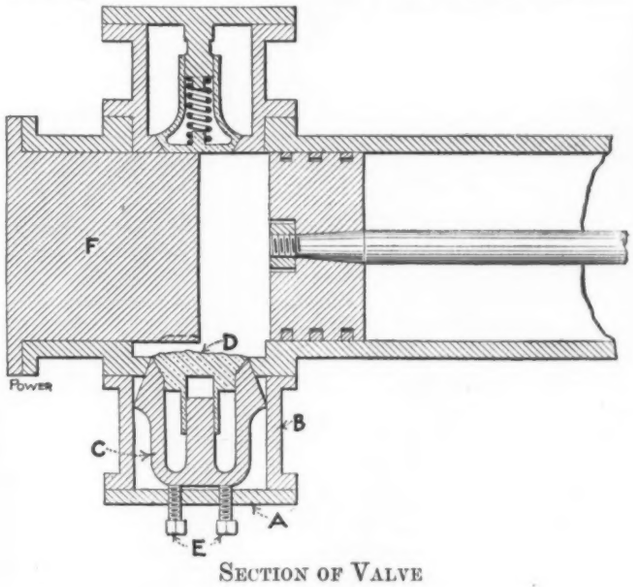
New Bedford, Mass.

What Broke the Valve?

The suction valve blew out of a Ball ammonia compressor of the horizontal, double-acting type without warning or other signs of distress. The illustration shows the design of the suction and discharge valves. We found the bonnet *A* cracked in four pieces and the valve pot body *B* cracked the whole length on one side and part way in another place.

Numerous reasons were suggested to account for the accident. One was that a slug of liquid had caused the damage, but it was pointed out that it would be easier for the liquid to pass out through the discharge valve than to break the suction valve; besides, the machine was running rather warm at the time and this would not be the case if there was liquid enough present in the suction line to cause any trouble.

Another suggestion was that the setscrews *E* holding the cage *C* in place had backed out and allowed the cage to work up and down and hammer the bonnet until it cracked and blew out. This did not seem plausible either, because the cage is quite heavy, and the pressure has no tendency to shift it, and the valve *D*, if it was working free, would not lift it. However, the setscrews



SECTION OF VALVE

were gone over regularly on all the machines every week for some time, but none of them had worked loose.

Three months later another valve blew out under identically the same circumstances on another machine. This time we noticed that the valve *D* had curled up on one edge, as if something had struck it a heavy blow. On closer examination, a mark on the piston near the bottom indicated where it had struck the valve. The valve, however, had no business being in a position where the piston

could hit it when the piston was coming back if it was working properly, and even if it should stick open, the cylinder head *F* would prevent it from getting high enough for the piston to hit it.

It was found, however, that the cylinder head was worn away from the constant hammering of the suction valve every time it opened as indicated by the dotted lines. This tended to cock the valve over on one side when it struck the head and most likely caused the valve to stick; it also allowed the valve to raise high enough for the piston to hit it when it came back, thus causing the break.

To avoid further trouble, we turned the cylinder heads on each end of each machine half a turn, which gives a new surface for the valve to strike against and prevents it going up too far.

THOMAS G. THURSTON.

Chicago, Ill.

Home-Made Cable Clamp

Referring to the article by Walter R. Hodge, reprinted from the *Engineering & Mining Journal*, in the Aug. 4 issue of POWER, I would state that if anyone wants these clamps, it is not necessary to have a blacksmith make them; this style of clamp is furnished by oil-well and mill-supply dealers.

Such clamps are made for all sizes of cables from 3/8 to 1¼ inch. The discount prices range from $1 to $4 per dozen. The clamps are usually furnished either in plain or galvanized iron.

L. M. JOHNSON.

Emsworth, Penn.

Examination Questions

Following are the questions asked recently by the board of examiners in Boston, of applicants for a second-class engineer's license, as sent in by one of our subscribers.

1. If at varying loads a McIntosh & Seymour engine runs slow or fast, how do you adjust the governor to make it run steadily?
2. How does the automatic work on a Pickering governor?
3. What braces are needed in the Heine boiler?
4. How do you test the Pickering governor to see that it is working?
5. If your fireman came up and told you the feed pipe was blocked with scale, how would you tell, without going inside of the boiler?
6. How do you feed from the heater to the boiler?
7. How do you distinguish the suction valve on a Deane duplex pump, also the discharge valve?
8. How do you pack the piston on this pump?
9. If you have two pumps exactly alike, one being used for feeding boilers and the other for pumping out-doors, how can you tell which is which, if all piping is concealed?
10. Can a single-acting pump be made to work double-acting?
11. If the end of the blowoff runs into a tank, how can you tell where a leak may be?
12. If you had a battery of six boilers, and the blow-off pipe broke on one of them, what would you do?
13. What and where is the follower plate on a pump?
14. Which is the direct and which the indirect side of a pump?
15. How do you find the clearance on an engine?
16. How does the valve gear operate on the Brown engine?
17. How does it operate on the Rollins engine?
18. How does it operate on the Putnam engine?
19. How high a lift has the poppet valve on the Putnam engine?
20. Suppose you lengthen the long reach rod, and shorten the short one, what effect does it have on the tandem compound engine?
21. What effect will the same adjustment have on a single-cylinder engine?
22. How would you ease up on the crankpin of the high-pressure side of a cross-compound engine when heating?
23. Suppose your fireman came up and said the piston on the direct side of the pump was broken; which side would you look at?
24. What difference would it make to the clearance by keying up on a solid end connecting-rod, and what difference would it make on one having gib and key?
25. At what point of the stroke does a slide valve cutoff?
26. How would you fix it to make it cut off at seven-eighth stroke?
27. How do you set a shaft governor?
28. If you had the valves on a riding cutoff one opening ¾ in. more than the other, how would you alter it?
29. If you bank your fires at night, and have plenty of water in the boiler—you come in the next morning and find the water out of sight; where did the water go?
30. If your engine is cutting off at one-fourth, then one-half, then two-thirds stroke, what is the trouble?
31. How much lap would you give a slide valve?
32. If one of the pistons is going slowly and the other going quickly on a duplex pump, what is the matter?
33. If you key up both crankpin and wristpin, would it make any difference to the clearance?
34. Is a compound engine more economical than a single-cylinder engine?
35. Is a single or duplex pump the most economical?
36. In case of accident, which is the quickest way to shut down a four-valve condensing engine not equipped with electric stop motion?
37. If the emergency stop and emergency throttle valve on a 1000-kw. Curtis steam turbine was out of commission, and the turbine dropped its exciter, what would you do?
38. What are the precautions to be observed when synchronizing or phasing a turbine set with a reciprocating set?
39. What do you understand by power factor?
40. What is a direct engine?
41. How would you place the eccentric back if it should slip?
42. What kind of valve is between the pump and pressure tank of a hydraulic elevator?
43. If there was too much air in the pressure tank, what effect would it have on the elevator?
44. If the governor belt broke on a Corliss engine, would the governor prevent the engine from racing or accelerating to the point of explosion?
45. How would you set a Corliss engine governor?

Engineers' Study Course

Elementary Mechanics--XXVI

LAST LESSON'S ANSWERS

116. The time of flight, which is independent of the velocity of projection, may be found from equation (67), where $T_1 = \sqrt{\frac{2H}{g}}$. As the conveyor is 100 ft. above the ground the value of H is 100 ft., hence

$$T_1 = \sqrt{\frac{2 \times 100}{32.16}} = \sqrt{6.22} = 2.5 \text{ sec.}$$

117. While the coal is falling it is also moving horizontally at the rate of 20 ft. per sec. From problem 116 the coal strikes the ground 2.5 sec. after leaving the conveyor; therefore, the point where the coal lands is at a horizontal distance of

$$2.5 \times 20 = 50 \text{ ft. from the conveyor.}$$

118. At the instant it strikes the ground, the coal has two velocities—one of 20 ft. per sec. horizontally, represented by the line AB, Fig. 77, and a vertical one, due to gravity, represented by the line AD. The value of the velocity, due to gravity, is given by equation (41) where $V = gT_1$. In this case the time of flight is 2.5 sec., hence the velocity $AD = 32.16 \times 2.5 = 80.4$ ft. per sec. The resultant velocity is given by the diagonal AC of the parallelogram $ABCDA$.

But $\overline{AC}^2 = \overline{AD}^2 + \overline{DC}^2 = 80^2 + 20^2 = 6800$, or

$$AC = \sqrt{6800} = 82.5 \text{ ft. per sec.}$$

The resultant AC makes an angle BAC (see Fig. 77) with the horizontal. But $\sin BAC = \sin a = \frac{BC}{AC} = \frac{80}{82.5} = 0.97$. From a table of sines the angle a is found to be 76 deg.

119. The linear velocity of the ball is equal to $2 \times 3.1416 \times R \times N$, where R = the distance from the center of the spindle to the center of the ball, and N = the r.p.m., or

$$V = 2 \times 3.1416 \times \tfrac{15}{12} \times 100 = 785 \text{ ft. per min., or } 13 \text{ ft. per sec.}$$

If the ball were to break loose from the arm, it would move horizontally with a velocity of 13 ft. per sec., and at the same time gravity would pull it toward the ground. The time that would elapse before the ball strikes the ground is dependent upon the height of the ball from the ground, which is 15 ft. From equation (42), $H = \frac{1}{2} gT_1^2$, or $T_1 = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 15}{32.16}} = 1$ sec. (approx.) During this same time the ball would travel 13 ft., that is, the ball would strike the ground 13 ft. from the governor.

120. From problem 119, the time of flight is found to be one second.

PROJECTILES (continued)

Class III. Bodies projected at an angle to the horizontal.

In Fig. 78, assume an object to be projected from the point A with a velocity of V feet per second, at an inclination of a degrees with the horizontal, and let the line AB represent this velocity. Through the point A draw the horizontal and vertical reference lines AK and AN and on the diagonal AB construct the parallelogram $ANBMA$. The line AM will then represent the horizontal component of the velocity V, and will give the rate at which the projectile is moving horizontally. Likewise the line AN will represent the vertical component of the velocity V and gives the rate at which the projectile is moving vertically. The only force opposing the component V_1 is the resistance of the air, which, in this discussion, is assumed as zero, hence as long as the projectile is above the ground it will have a uniform horizontal displacement of V_1 feet per second.

The component V_2 is being reduced at a uniform rate by the action of gravity until finally it becomes zero, at which instant the projectile has reached its maximum elevation above the ground as represented by the point S, in Fig. 78. From this point on, the action of gravity is greater than the vertical velocity, with the result that the projectile is gradually drawn toward the earth and finally reaches it at the point K. The distance $ST = H$ gives the maximum height the body will rise and the distance $AK = R$ represents the range of the projectile.

At the end of the first second of flight the projectile would be at the point B, distant V feet from the point A, but during this second gravity acts and pulls the object toward the earth a distance of $\frac{1}{2} gT_1^2$ ft., or 16 ft., so that the true position of the projectile is at C, 16 ft. below B. Likewise at the end of the second second the projectile is at F, located $\frac{1}{2} gT_1^2$, or 64 ft. below D.

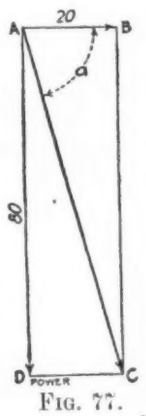


FIG. 77.

The path of the projectile may be plotted in a manner similar to that explained under Case II. Thus, through the point of projection A draw the line AK, and also the line AE at an angle of a degrees to AK, to represent the direction of projection. On this line locate the points A, B, D, E, etc., distant V, $2V$, $3V$, etc., from A. Through the points B, D, E, etc., draw the vertical lines BC, DF, EG, etc., and on these lay off to scale the distances through which a body would fall due to gravity in the given number of seconds. Thus at the end of the first second, the projectile would be at C, at the end of the second second at F, etc. A smooth curve drawn through these points will give the path or the trajectory of the body.

In Lesson XIX, it was shown that if a body be projected vertically upward with a given velocity that the total time of flight would be $T = \frac{2U}{g}$ seconds, where U is the vertical velocity of projection. In this case the vertical velocity is the vertical component of the velocity V, or $V \sin a$, hence when a body is projected at an angle

of a degrees to the horizontal with a velocity of V feet per second, the total time of flight will equal $\frac{2 \times V \sin a}{g}$, or,

$$T_1 = \frac{2 V \sin a}{g} \qquad (70)$$

The range, or horizontal displacement of the projectile, will equal the horizontal component V_1, or $V \cos a$, times the whole time of flight, or,

$$R = V \cos a \times T_1 \qquad (71)$$

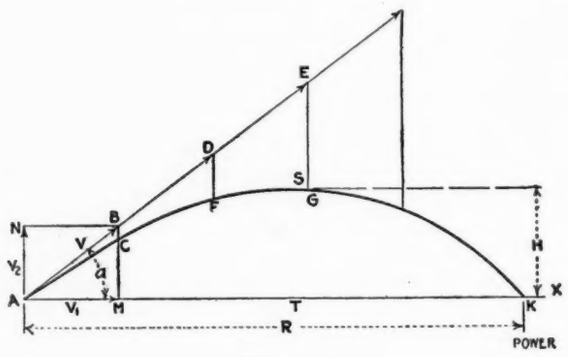


FIG. 78.

Now substituting the value of T_1 from equation (70), in equation (71), there results,

$$R = V \cos a \frac{2 V \sin a}{g} = \frac{2 V^2 \sin a \cos a}{g}$$

but from the lessons in Trigonometry, $2 \sin a \cos a = \sin 2a$, therefore

$$R = \frac{V^2 \sin 2a}{g} \qquad (72)$$

When the angle $a = 45$ deg., the angle $2a = 90$ deg., and $\sin 2a = \sin 90 \text{ deg.} = 1$, and hence the horizontal range $R = \frac{V^2 \sin 90 \text{ deg.}}{g} = \frac{V^2}{g}$.

This demonstrates that a projectile will have its maximum range when the angle of projection is 45 deg.

The maximum height H that the projectile will rise above the horizontal is dependent upon the vertical component V_2 of the velocity V. Thus the value of H may be found from equation (43) by substituting for V the velocity $V_2 = V \sin a$, thus,

$$H = \frac{V^2 \sin^2 a}{2 g} \qquad (73)$$

The velocity with which the projectile is moving vertically at any given instant during the flight may be found by considering that there are two velocities acting —one of $V \sin a$ upward, due to the initial velocity of projection, and one of gT feet downward, due to gravity. Let U = the vertical velocity at the end of T seconds, then,

$$U = V \sin a - gT \qquad (74)$$

where T = the time that has elapsed from the instant of projection.

If the value of U works out negative, it indicates that the projectile has reached its maximum elevation and has started downward.

There is a special case coming under Class III, namely, when a body is projected from a point at a given elevation from the horizontal, as, for example, the firing of a projectile from a cliff. The time of flight in such a problem may be determined as follows:

Let H = the elevation of the point of projection. Then the total net vertical displacement of the projectile will be $-H$ feet, as the projectile must rise to its highest point and then fall H feet below the point of projection. The vertical velocity is $V \sin a$. From equation (38), $S = UT - \frac{1}{2} gT^2$, and as $S = -H$, and $U = V \sin a$, it follows that,

$$-H = V \sin a \times T - \tfrac{1}{2} gT^2 \qquad (75)$$

where T is the total time of flight.

STUDY QUESTIONS

121. A 12-in. gun discharges a projectile with a velocity of 1200 ft. per sec. If the gun is inclined to the horizontal at an angle of 45 deg., find the time of flight.

122. At what distance from the gun will the projectile strike the ground?

123. Find the maximum distance that the projectile rises above the ground.

124. If the gun is on a cliff 500 ft. above the sea, where would the projectile strike the water if fired under the conditions stated in problem 121?

125. What is the total time of flight?

Boston's Smoke Report

The annual report of the Board of Gas and Electric Light Commissioners for Massachusetts which enforces the smoke law for Boston and vicinity, shows that for 1913 this work was carried on with good results.

As many know, the smoke law for Boston classifies stacks, stationary, marine and locomotive; the locomotive class covers all locomotives without regard to size while stationary and marine stacks are subdivided on a top-area basis, each size stack being allowed to emit objectionably dense smoke for time limits based on the smoke density, anything above and including No. 2 Ringelmann chart being considered dense.

During the year observations were made of 35,424 stacks, 27,423 being stationary, 7393 locomotive and 608 marine. Of these, 930 stationary, 252 locomotive and 43 marine stacks emitted smoke in excess of the amount allowed by the law. The number of stationary stacks emitting smoke in excess of the amount allowed, due to carelessness of operation was 773 against 944 for 1912. Observations were made on stacks of 115 public-service plants, 485 manufacturing plants, 297 office-building plants and two for residences. Of these, those emitting smoke in excess of that allowed were public service, 64; manufacturing, 225; and office buildings, 76.

The law went into effect July 1, 1900, and the comparative figures for the three years show gratifying progress.

Ellison Cement—After several years of experimentation on a cement for glass tubes in metal casings which would not be affected by mineral oils and would yield under expansion in setting, thus relieving the glass and cement cup of undue strains, an excellent cement has been developed by Lewis M. Ellison, as follows: Two parts litharge and three parts granulated cork, fineness of about granulated sugar, mixed with glycerin to usual consistency; coated, when set, on the surfaces exposed to atmospheric action with valspar or similar varnish. The cork compensates for the expansion, litharge-glycerin cement being too hard and having too great expansion. For level glasses, plaster of paris mixed with water being too hard for thin wall glass and also having too great expansion in setting, two parts plaster is mixed in water with one part cork.

Proposed Changes in Massachusetts Boiler Rules

In compliance with Sect. 26, Chapt. 465 of the Acts of 1907, Commonwealth of Massachusetts (as amended by Sect. 2 of Chapt. 393 of the Acts of 1909), a public meeting will be held by the Board of Boiler Rules* to consider the following changes in the present Massachusetts steam boiler rules.

PART II

SECTION 1

Paragraph 1—The pressure allowed on a boiler constructed wholly of cast iron, and boilers known as cast iron sectional boilers, shall not exceed fifteen (15) lb. per sq.in.

Paragraph 2—The pressure allowed on a boiler the tubes of which are secured to cast iron headers, also on cast iron mud drums and malleable iron headers or mud drums, shall not exceed fifteen (15) lb. per sq.in.

Paragraph 6—(Additional.) The shearing strength of the rivets and the crushing strength of the plate in front of the rivets shall be ample to take care of the pressure on the head.

Paragraph 7—The lowest factors of safety used for boilers, the longitudinal joints of which are of lap-riveted construction, shall be as follows:

(e) Boilers over twenty-five (25) years old, of lap-seam construction, shall not carry a pressure in excess of fifteen (15) lb. per sq.in.

SECTION 2

Paragraph 9—Interpolate, after the word degrees in fourth line, the words, or about ninety (90) degrees.

Paragraph 10—Fusible plugs, as required by Sect. 20, Chapt. 465, Acts of 1907, shall conform to the following specifications:

SPECIFICATIONS FOR MASSACHUSETTS STANDARD FUSIBLE PLUGS

All fusible plugs shall consist of a bronze casing, holes in which shall be reamed and tinned before being filled, and shall be filled with Banca tin.

All fusible plugs shall be stamped by the manufacturers with their names across the face of the plugs with letters not less than one-eighth of an inch (⅛") in height, and the letters MASS. STD.

The outside diameter of the plug is to be of the standard pipe threads.

No fusible plug shall be used for a longer period than one (1) year.

Paragraph 12—Add to subparagraphs (l), (m), (q), (r) and (t) the words, and extending not less than one inch (1") inside of boiler.

Paragraph 13—Interpolate the word "brass" before the word syphon on second line.

Paragraph 17—Each boiler shall have two (2) or more gage cocks, the centers of which shall be located vertically within the range of the visible length of water glass, when the maximum pressure allowed does not exceed fifteen (15) lb. per sq.in., except when such boiler has two (2) water glasses located not less than three (3) feet apart on the same horizontal line.

Paragraph 18—Each boiler shall have three (3) or more gage cocks, the centers of which shall be located vertically within the range of the visible length of water glass when the maximum pressure allowed exceeds fifteen (15) lb. per sq. in., except when such boiler has two (2) water glasses, located not less than three (3) feet apart, on the same horizontal line.

Paragraph 25—When there are two (2) connected boilers (gravity return system), one check valve and a stop valve shall be installed in the branch pipe to each boiler. (Omit Fig. 1, as shown.)

SECTION 3

Paragraph 2—A boiler having two (2) sq.ft. of grate surface shall be rated at three (3) hp. when the safety valve is set to blow at fifteen (15) lb. per sq.in. or less.

SECTION 6

Paragraph 1—When a boiler is tested by hydrostatic pressure the pressure applied shall not be less than one and one-quarter (1¼), nor more than one and one-half (1½) times the maximum allowable working pressure; except that twice the maximum allowable working pressure may be applied on boilers permitted to carry not over fifteen (15) lb. pressure per sq.in.

Paragraph 2—When making annual inspections on boilers constructed wholly of cast iron, or boilers known as cast iron sectional boilers, a hydrostatic pressure test of not less than fifteen (15) lb. and not more than twice the maximum allowable working pressure, shall be applied.

PART III

Page 21—(Heading.) These rules, in addition to the rules contained in Part II, apply to boilers installed after May 1, 1908, and to any repairs or changes made hereafter.

SECTION 1

Paragraph 3—There shall be two (2) classes of open hearth boiler plate and rivet steel; namely, firebox steel and extra soft steel, which shall conform to the following limits in chemical composition:

	Firebox Steel (Per cent.)	Extra Soft Steel (Per cent.)
Phosphorus shall not exceed.....	Acid 0.04 Basic 0.03	Acid 0.04 Basic 0.04
Sulphur shall not exceed.....	0.04	0.04
Manganese	0.30 to 0.50	0.30 to 0.50

Paragraph 5—The two (2) classes of open hearth boiler plate and rivet steel—namely, firebox steel and extra soft steel—shall conform to the following physical qualities:

	Firebox Steel	Extra Soft Steel
Tensile strength, pounds per square inch	52,000 to 63,000	45,000 to 55,000
Yield point, in pounds per square inch, shall not be less than	½ T. S.	½ T. S.
Elongation per cent. in eight inches shall not be less than	26	28

Paragraph 7—The two (2) classes, etc.

Paragraph 7 (d)—Omit the words "flange or boiler steel."

SECTION 2

Paragraph 1—Shells, drums, butt straps, heads, combustion chambers, furnaces, or any plates that require staying or flanging, shall be of open hearth firebox or extra soft steel, as specified in paragraphs Nos. 3 and 5, Sect. 1, Part III of these rules.

Omit paragraph 2.

SECTION 3

Paragraph 6—Cross pipes connecting the steam and water drums of watertube boilers, and cross boxes, shall be of wrought or cast steel when the working pressure exceeds fifteen (15) lb. per sq.in.

Paragraph 7—Mud drums of watertube boilers shall be of wrought or cast steel when the working pressure exceeds fifteen (15) lb. per sq.in.

Paragraph 8—Pressure parts of superheaters, attached to the boilers or separately fired, shall be of wrought or cast steel. Cast iron for superheat is prohibited.

Paragraph 10—Waterleg and door frame rings, of vertical firetube and locomotive type boilers shall be of wrought or cast steel, or wrought iron.

After present paragraph 11. DOMES or DRUMS.

Domes or drums shall only be allowed on a locomotive type boiler, and shall be located on the barrel of the boiler, but not on the wagon top.

Domes or drums shall be made of the same thickness and quality of material as the boiler shell.

When the pressure desired does not exceed one hundred (100) lb. per sq.in. the longitudinal joints of such domes or drums shall be of double riveted lap construction, and the flange shall be double riveted to the boiler shell.

Heads of domes or drums shall be convex.

When a hole larger than four inches (4") in diameter is required in a boiler which is constructed with a dome it shall be reinforced to compensate for the metal removed.

At least two (2) drain holes three-quarters of an inch (¾") in diameter shall be located in the shell under a dome, at the lowest point where water can collect, for the purpose of draining.

Paragraph 2—A manufacturer who desires to construct Massachusetts Standard boilers shall send a written application to the Board of Boiler Rules, and receive written authority from said Board before taking any steps toward the construction of a Massachusetts Standard boiler. A detailed list of shop equipment must accompany the manufacturer's application for such authority; also advice of the

*Address, State House, Boston, Mass.

name of the State inspector or of the authorized inspector holding a certificate of competency as an inspector of steam boilers for this Commonwealth and in the employ of an insurance company authorized to inspect and insure steam boilers for this Commonwealth, who will examine during construction and stamp Mass. Std. upon completion a boiler constructed in strict accordance with these rules. Upon receipt of said application the Board will designate the style of stamping which it will approve, after the following model:

MASS. STD.
1
(Designation by Board.)

The manufacturer shall then submit a five-inch by three-inch (5-in.x3-in.) brass or copper plate, showing exactly the style of stamping designated by the Board, for approval; the height of letters and figures to be not less than one-fourth of an inch (¼-in.).

Paragraph 2—Renumber this paragraph, last six lines to read:

Each boiler shall be stamped by the builder, in the presence of the inspector, with a serial number and with the style of stamping shown in the facsimile previously approved by this Board.

Before present paragraph 3:

Any inspector holding a certificate of competency as an inspector of steam boilers for this Commonwealth may make final inspection and test on a boiler built under the rules of the Board of Boiler Rules of the Commonwealth of Massachusetts, provided the manufacturer of said boiler, or his representative, makes affidavit under oath that said boiler has been so constructed, and furnishes the record of a properly authorized inspector who has followed the construction of the boiler.

Before Paragraph 10—The efficiency of the longitudinal joint of a shell or drum when welded by the forging process shall not exceed the following:

55.0 per cent. when the shell plates are stamped 52,000 T. S.

54.0 per cent when the shell plates are stamped 53,000 T. S.

53.0 per cent. when the shell plates are stamped 54,000 T. S.

52.0 per cent. when the shell plates are stamped 55,000 T. S.

51.1 per cent. when the shell plates are stamped 56,000 T. S.

(Note—56,000 lb. will be the highest tensile strength used in calculating the maximum allowable working pressure on a shell or drum the longitudinal joints of which are welded by the forging process, this being irrespective of a higher tensile strength than 56,000, which may be stamped on the plates. The formula for calculating the working pressure is given in Paragraph I, Sec. 4, Part III of these rules.)

SECTION 4

Paragraph 16—The minimum thickness of a convex head shall be determined by the following formula, excepting that said thickness shall not be less than one-fourth of an inch (¼ in.):

$$\frac{8.33\ R \times P}{T.S.} = t$$

The minimum thickness of a concave head shall be determined by the following formula, excepting that said thickness shall not be less than one-fourth of an inch (¼ in.):

$$\frac{8.33\ R \times P}{0.6\ (T.S.)} = t$$

Paragraph 16—(Addition to paragraph). The radius to which the head is bumped shall be at least equal to the diameter of the shell to which the head is attached.

The radius to which the curve shall be made close to the flange on a concave or convex head, shall be not less than four (4) times the thickness of the material in the head.

Paragraph 18—When a convex or concave head has a manhole opening, the flange shall be turned inward, and to a depth of not less than three (3) times the thickness of the head, measured from the outside of the boiler.

Paragraph 25—(Add to paragraph). The vertical pitch of staybolts, measured from the rivets in the lower tube sheet to the first row of staybolts, shall not be greater than the prevailing pitch of staybolts.

Paragraph 31—When a flat-head has a manhole opening, the flange of which is formed from the solid sheet and turned inward to a depth of not less than three (3) times the thickness of the head, measured from the outside of the boiler, an area two (2) inches wide all around the manhole opening, as shown in Fig. 16, may be deducted from the total area of head, including manhole opening, to be stayed.

Present figure 17 to be renumbered 16, and similar change made in numbers of all figures, on account of omitting figure number 1.

Paragraph 33—(Add to paragraph). Stayrods longer than three (3) ft., such as are used for bracing the segment of a circle, shall have not less than 0.7854 sq.in. sectional area.

Before Paragraph 40—All staybolts shall be drilled, both from the outside and inside ends, to a depth of not less than one-half inch (½ in.) inside the boiler plate, and their diameter shall be three-sixteenths of an inch (3/16 in.).

Before Paragraph 40—All nozzles on boilers shall be of pressed or cast steel, when the pressure desired is greater than fifteen (15) lb. per sq.in.

Paragraph 40—Omit the example and the formula at end of paragraph.

Before Paragraph 41—All boilers and parts of boilers shall be three-sixteenths of an inch (3/16 in.) thick.

Paragraph 41—The thickness of cast iron blank flanges shall not be less than that specified by the manufacturers' standard for high pressure.

Paragraph 46—The calking edges of plates and heads shall be beveled. Calking shall be done with a round-nosed tool.

Before Paragraph 47—The edges of plates and butt straps, inside and outside of boiler, shall be planed to a depth of not less than one-eighth of an inch (⅛ in.) to remove the crystallized metal caused by the action of the shear.

Before Paragraph 51—SPECIFICATIONS FOR TUBES.

Tubes for water-tube boilers, pipe boilers or superheaters shall be made without welds, and shall be seamless drawn.

Tubes for fire-tube boilers may be welded of steel or charcoal iron.

The physical tests of all tubes shall be as follows:

Tubes shall be free from all surface defects. The defects to be particularly avoided in seamless tubes are tears, snakes, checks, slivers, scratches, laps, pits, rings and sinks.

All seamless-steel cold-drawn tubes shall be annealed as a final process. One or more tubes shall be selected at random from each charge of the annealing furnace, and coupons cut from them for testing.

TEST ONE—A piece three inches (3 in.) long, cut from the first tube, shall be flattened by hammering until the sides are brought parallel with the curve on the inside at the ends not greater than three (3) times the thickness of the metal, without showing cracks or flaws.

TEST TWO—A flange shall be turned all around the end of the tube to a width equal to three-eighths of an inch (⅜ in.) beyond the outside body of the tube.

Tests one and two shall be done cold.

When hot finished tubes are furnished, the tubes shall pass the same manipulating test as cold-drawn tubes, but do not have to be annealed. Each tube shall be subjected to an internal hydrostatic pressure of one thousand (1000) lb., without showing signs of weakness or defects.

All tubes shall stand expanding, flanging over on the tube plate, and beading, without flaw or crack.

All lap-welded tubes shall be made of charcoal iron or mild steel, and shall conform to the following tests:

Tubes shall be free from defective welds, cracks, blisters, scale, pits and sand marks.

The following tests shall be made before shipment by the manufacturer:

TEST ONE—A test piece three inches (3 in.) in length, cut from a tube, shall be flattened by hammering until the sides are about parallel with the curve on the inside at the end, not more than three (3) times the thickness of the metal without showing cracks or flaws, with bend at one side being in the weld.

TEST TWO—A second tube shall have a flange turned over at right angles to the body of the tube, and shall have a width equal to three-eighths of an inch (⅜ in.) beyond the outside body of the tube.

All work done shall be done cold.

Each tube shall be subjected to internal hydrostatic pressure of five hundred (500) lb. per sq.in., without showing signs of weakness or defects.

All steel tubes shall have ends properly annealed by the manufacturer, before shipment, and shall stand expanding, flanging over on the tube plate, and beading, without flaw, crack or opening in the weld.

The manufacturer of boiler tubes shall furnish to the purchaser of each lot of tubes a statement of the kind of material of which the tubes are made, and that the tubes have been tested and have met all the requirements of the rules. The statement shall be furnished to the boiler manufacturer using the tubes, who shall show them to the boiler inspector when shop inspection of the boiler is made.

(After the foregoing specification for tubes)—The first two rows of tubes exposed to products of combustion, in

water-tube boilers, shall be two (2) gages heavier than the prevailing thickness of tubes in said boilers.

(Second paragraph after specification for tubes)—No lap-welded tube shall be used in water-tube boilers. No old boiler shall be retubed with lap-welded tubes.

Paragraph 52—When it is necessary to place a fusible plug in a tube, an extra thick tube shall be provided for that purpose, which shall not be less than three-eighths in.

Paragraph 53—(After the tabulation). If the thickness of the material in the boiler is not sufficient to give such number of threads, there shall be a standard commercial pressed-steel flange, cast-steel flange or steel plate, substantially riveted to the boiler, so as to give the required number of threads. A feed-pipe connection shall be fitted with a brass or steel boiler bushing.

(Before paragraph 54)—SPECIFICATIONS FOR CAST STEEL.

Chemical properties:

Phosphorus, not over 0.05 per cent.

Sulphur, not over 0.05 per cent.

Physical properties.

Tensile strength, lb. per sq.in., 50,000 to 60,000.

Elongation in 2 in. 23 per cent.

Reduction of area, 30 per cent.

All steel castings must receive such heat treatment as will produce fine grain, homogeneous and tough metal, free from slag, cracks and cavities, injurious blowholes or other defects.

Cast-steel, cast-iron or malleable-iron boiler fittings shall not be used unless made by regular processes and by manufacturers who stamp such fittings with their trade mark or identifying stamp, and who guarantee the castings to possess the chemical and physical properties stated in these rules.

Before Paragraph 58—There shall be not less than eleven-sixteenths of an inch ($\frac{11}{16}$ in.) bearing surface for a manhole gasket.

Paragraph 64—A vertical fire-tube boiler which does not have a manhole, except the boiler of a steam fire engine, shall have not less than seven (7) handholes, located as follows:

Two (2) in the shell at or about the line of the crown sheet, and diametrically opposite each other.

One (1) in the shell at or about the line of the fusible plug, except a vertical fire-tube boiler having a manhole in the shell or head, through which the fusible plug is accessible.

Two (2) in the shell at the lower part of the waterleg, and diametrically opposite each other.

Two (2) located at or about the waterline of the boiler, and diametrically opposite each other, except a vertical fire-tube boiler having a manhole.

Paragraph 88—Omit the words, or cast iron, in fourth line.

Paragraph 69—Omit the words, or cast iron, in third line.

Paragraph 70—(Addition to paragraph)—No cast iron shall be used in lugs or brackets in any steam boiler.

Before Paragraph 71—REINFORCING PLATES WHERE BRACKETS ARE ATTACHED.

In all cases where brackets or other fixtures subjected to any working strain are attached to a portable boiler, the plates to which these brackets are attached shall be reinforced with plates of the same thickness as the outer plates of the boiler, and securely riveted together. The outer rows of rivets attaching reinforcing plates to boiler must be at least three inches (3 in.) outside of the bracket. All brackets shall be properly fitted to the plates, flat or curved, with stud holes drilled to suit the holes in the brackets, which must be drilled to templets; and the studs attaching same shall be tapped through both plates where reinforced. No tap bolts will be allowed.

SECTION 5

Paragraph 4—Omit the words, and thirty-five, and change figure to 100.

Paragraph 5—Omit the words, and thirty-five, and change figure to 100.

Paragraph 7—Omit paragraph.

Paragraph 8—The feed pipe of a boiler shall have open end or ends. When one or more globe valves are used on a feed pipe, the inlet shall be under the disk of the valve.

Paragraph 9—The feed water shall discharge about three-fifths ($\frac{3}{5}$) the length of a horizontal return tubular boiler from the front head, and at or about the central rows of tubes above the tubes, when the diameter of the boiler exceeds thirty-six inches (36 in.) and the pressure allowed exceeds fifteen (15) lb. per sq.in. The feed pipe shall be carried through the head with a brass or steel boiler bushing and securely fastened inside the shell above the tubes.

Before Paragraph 10—When a horizontal return tubular boiler, the diameter of which does not exceed thirty-six (36 in.), has no manhole opening, and the pressure desired is greater than fifteen (15) lb. per sq.in., the feed pipe shall enter the front tube sheet above the tubes, and below the waterline of the boiler, through a bushing, and an internal feed pipe, not less than three (3) ft. in length, screwed into said bushing, the end of said pipe being open.

Paragraph 13—In fourth line, change pressure to fifteen (15) lb. per sq.in.

Paragraph 17—In first line, change pressure to fifteen (15) lb.

Paragraph 18—In second line, omit the words, and thirty-five, and change figure to 100.

Paragraph 23—In second line, change pressure to fifteen (15) lb.

Before Paragraph 24—BLOWOFF ON WATER COLUMN.

On each water connection to a water column where there is a right-angle turn, there shall be located at least one (1) gate valve and pnpe of a diameter not less than one-half inch ($\frac{1}{2}$ in.), for the purpose of blowing out said water pipe, except a right-angle turn inside of smoke box.

Paragraph 31—Make this paragraph, paragraph 4, sec. 6, part 2, p. 13.

After present paragraph 31—When a dry pipe is used in the steam space of a boiler, it shall be made of the standard thickness of pipe, and be properly secured; shall have both ends closed, and shall be slotted on the top side of the pipe. The area of the slots shall be equal to not less than four times the area of the steam outlet.

SECTION 6

Omit paragraphs 1 ad 2.

Paragraph 3—Omit the words, passed by joint, and change the word inspection to the word inspected.

Omit present paragraph (a) and change other paragraphs as follows:

(a) Six (6) for boilers, the longitudinal joints of which are of lap-riveted construction, diameters up to and including thirty-six inches (36 in.).

(b) Eight (8) for boilers, the longitudinal joints of which are of lap-riveted construction, diameters over thirty-six inches (36 in.).

(c) Four and five-tenths (4.5) for boilers, the longitudinal joints of which are of butt and double-strap construction, age not exceeding ten (10) years.

(d) Five (5) for boilers, the longitudinal joints of which are of butt and double-strap construction, age over ten (10) years.

The hydrostatic pressure test on such boilers shall be one and one-half (1½) times the maximum allowable pressure obtained by using the above factors of safety.

Page 52—(Before repealing clause.)

A boiler on which a lap crack is discovered shall be immediately discontinued from service.

The ogee form of construction at the lower end of furnace sheet is hereby prohibited.

An English Boiler Explosion

On the morning of Aug. 17 a large Rastrick boiler, heated by waste gases, exploded in the puddling shed of the Thornkill Iron and Steel Works, Dewsbury, Yorkshire, England, converting iron buildings and a group of puddling furnaces into a tangled mass of debris. Of 35 men employed in the puddling shed seven were killed and nearly all were injured.

The evidence given at the inquest revealed a tragically simple solution of the disaster, as reported in "The Mechanical Engineer" of Aug. 21. Shortly after six o'clock, on the morning of the explosion, the chief engineer of the works noticed that steam was issuing rather freely from the lever safety valve, and presuming that it was due to leakage, instructed the engine-driver to hang a little more weight on the lever and this he proceeded to do by slinging an iron bar on it by means of S hooks in the belief that since the boiler was coupled to others, any excess of pressure would be relieved by their safety valves. It appeared that when the escape of steam was first noticed the pressure was then above the working point, and that the stop valve was closed so there was no outlet for the accumulating pressure until it burst the boiler. Had the boiler been fitted with duplicate safety valves, it is very improbable that both would have been defective at the same time and the escape of steam from both of them would have been more likely to excite suspicion and have prevented overloading of the boiler.

The Rastrick boiler has many objectionable features and among the older generation of English engineers has an unenviable reputation, owing to its association with some of the most disastrous boiler explosions on record.

The shell of this type of boiler is, roughly speaking, a plain vertical cylinder with hemispherical ends. It has been constructed with diameters ranging from about 6 ft. to as much as 9 ft., and heights from about 16 ft. to 25 ft. A vertical central flue tube extends from the bottom to about half the height of the shell, and is connected to it by two or four horizontal branches, according as the boiler is fired by waste heat from one or two pairs of puddling or heating furnaces. An annular brickwork flue is formed around the shell, divided by partition walls into as many compartments as there are furnaces. The waste heat from each furnace enters one of these compartments at the base of the boiler and thence through a damper to one of the horizontal branch tubes connecting to the central flue tube, through which the gases pass to the main flue leading underground to the chimney. The arrangement of the boiler and iron furnaces is compact since the boiler itself occupies little floor space, and the puddling or heating furnaces can be conveniently grouped around its base, which features have undoubtedly contributed to its extensive use in the past. But the virtues of the Rastrick boiler as a steam generator are so few and its vices so many that it has been largely discarded by the majority of English engineers in favor of special adaptations of the Lancashire, Cornish or water-tube type, though a few are still in existence."

Annual Convention of American Boiler Manufacturers' Association

The 26th annual convention of the American Boiler Manufacturers' Association was held at the Waldorf-Astoria, New York City, on Sept. 1, 2 and 3, and transacted considerable business of value not only to the association, but to boiler manufacturers generally, although the attendance of active workers present was less than had been expected.

A feature of the meeting was the opportunity afforded to still further advertise the coming hearing to be held in New York City on the 15th inst., pursuant to the call sent out by the A. S. M. E., to discuss their proposed new uniform specifications for boiler design, construction and materials.

The sessions were presided over by Vice-President Thomas M. Rees, of Pittsburgh, in the absence of President Meier, and the convention was opened by an address of welcome by Henry Bruere, city chamberlain, who referred to the changed attitude of municipal government toward the community with respect to efficient service for the public welfare. He said New York City had achieved a rather unenviable reputation in former years on account of its police graft scandals, etc., but that it had fully retrieved and has since furnished an example to the entire country of what can be accomplished for a city through the active participation of its best citizens.

W. H. S. Bateman, of Philadelphia, responded to the address of welcome, and took occasion to defend Philadelphia's reputation against the impeachment that the Quaker City is a little slow.

A recent circular letter of the Steamboat Inspection Service, referring to fusible plugs, was discussed by Messrs. Schaaf, Rees and others, Mr. Rees contending that those who were interested in Western river practice believe that there is no necessity of having more than one plug in the flue and one in the shell, and that the plugs should not be placed where they might necessitate the engineer lowering the water in order to get at them, as through such lowering of water there might be occasioned serious interference with the safe navigation of the boat. He did not believe there had ever been a case where a fusible plug properly made and properly placed had failed to give timely warning that the water in the boiler had fallen below the proper level. He thought the provision that the plugs must be renewed after four months' service was an unnecessary hardship, and in one case had occasioned an extra expenditure of about $1500.

H. J. HARTLEY stated that the Lloyds' requirements do not specify any plug at all, but on the first indication of a leak or blowout, a plug is merely screwed in and the matter remedied in that way.

A. J. SCHAAF stated that in the case of locomotive boilers, the requirements in the circular would make necessary the placing of three plugs in the crown sheet; one 12 in. from each end and one in the center. In a two-flue boiler, before this provision went into effect, one plug was placed 4 ft. from the forward end in the shell just under the fire line and one in the after end in the flue. He believed it a mistake to have an extra plug in a two-flue marine boiler in the middle of the flue on account of its being the coldest part of the boiler. If safety is the object, it ought to be in the shell 8 or 10 ft. from the forward end, where it would get the heat of the furnace.

The proceedings of the second day were opened by Secretary Farasey reading a communication from Colonel Meier, in which the latter made a strong plea for uniform boiler laws and specifications. He referred to the beneficial working of the steamboat and locomotive inspection laws under federal control, but said it would require a constitutional amendment to put stationary boilers under similar supervision. However, this difficulty could be overcome by having the different states accept the uniform specifications drawn up by the A. S. M. E. and concurred in by the various boiler interests.

Colonel Meier sent hearty greetings to the members present, with the assurance that only illness prevented his attendance. He also stated that it would be impossible for him to accept the presidency for another year. At the close of his sixth year's administration, he had never held an office in which he had been so generously and warmly supported as in that of presiding officer of the A. B. M. A.

Appropriate action on Colonel Meier's retirement was taken later.

JOHN A. STEVENS, from the committee of the A. S. M. E., addressed the convention, explaining the methods adopted by the A. S. M .E. in formulating its proposed standard specifications for the construction of steam boilers and other pressure vessels and for their care in service. He felt that regard for safety of life and property should far outweigh any consideration of cost, and the object of the new specifications was to insure the best possible design, construction and materials. He invited suggestions from all quarters, and stated that the opinions and criticisms of some sixteen hundred engineers who were recognized authorities on boiler design and construction had been requested by letter and the replies collated and considered; that the hearing on Sept. 15 was for the purpose of still further bringing out and discussing suggestions looking to the formulation of the very best specifications possible. He understood that the Wisconsin law recently enacted was being held up before being put into effect, awaiting the result of this conference, but was of the opinion that this law was a retrograde step from the proposed standard in that it called for reducing the factor of safety from 5 to 4½, and allowed the use of flange steel in place of firebox in boiler shells.

GEORGE A. LUCK, chairman of the Massachusetts Board of Boiler Rules, next read a schedule of certain proposed changes which the board is considering putting into effect, but which it is at present holding up for hearing until after the proposed A. M. S. E. conference on Sept. 15.

In reply to a question by C. S. Barnum, Mr. Luck stated that the board, with reference to welded joints, called for the forging process, not considering acetylene or electric welding advisable.

In reply to a question by John L. Gill, Mr. Luck stated that lugs or brackets were permitted to be attached to portable boilers with reinforcing pad, the wording of the rule being "may be." He explained that in Canada it is customary to put on lugs on portable boilers with reinforcing pads, and that the board had been requested to make the proposed change in order that boilers so built will be accepted in Canada as being in accordance with the practice there.

MR. GILL inquired, if a line of rivets went through the shell in a longitudinal position, whether this would not make a single-riveted boiler out of it so far as an allowance for pressure was concerned. Mr. Luck replied that it was not necessary to put the rivets so close together as to bring the boiler within less limits of pressure; that one does not have to reduce the efficiency in the joint, and besides, the reinforcing pad can be placed on the inside of the boiler.

L. E. CONNELLY, chairman of the Committee on Uniform Boiler Laws, then presented the report of his committee, which called attention to the lack of any boiler legislation during the past year, and reviewed briefly the coöperative work of the various societies toward uniform laws and specifications.

W. C. CONNELLY called attention to a recent communication received by him from several of the steel makers, in which he had been notified that on and after Oct. 1, they would refuse to accept orders for firebox steel with a range of more than 8000 lb. tensile strength.

A. B. CARHART urged the advantages of using two small pop safety valves on each boiler rather than one large valve, and emphasized the waste of coal and steam and the lack of economy through the frequent blowing of safety valves too large or unsuitable and the longer life of boilers secured by the use of accurate steam gages and well designed valves.

CHARLES F. KOOPMAN, referring to the matter previously mentioned by Mr. Connelly of leeway in tensile strength, thought that this would come up sooner or later in the Massachusetts law. He had just learned that under the Massachusetts law, another 1000 lb. was to be given, from 52,000 to 63,000, instead of from 52,000 to 62,000. The mills were asking for a leeway of 8000 lb., bringing the tensile strength down to 54,000 lb. In figuring on a 72-in. boiler, ½ in. thick, 150 lb. working pressure, this would mean a change in the construction of boilers in Massachusetts. This had been brought up in Boston, and the speaker had suggested to the mill that they refrain from making an arbitrary rule of that sort without first learning what effect it would have upon the boiler-manufacturing industry.

T. M. REES said he had always been a believer in high tensile strength, and he did not want to be confined to a low tensile strength, which would limit the thickness of the material. He always succeeded in getting the steel that he wanted by paying enough for it, and had just received word that after six years' constant service night and day with 185 to 190 lb. pressure, only one little fire crack had shown up on a certain piece of work.

MR. BLAKE said there had been some dispute as to the exact date when the first steel was worked in boilers, to which Mr. Rees replied that the first steel ever put in a steamer was in the mud drums of the steamer "Tom Rees" in 1869, which the local inspector at that time said must be taken out because made of steel and not iron. The builders refused to take them out because there was nothing in the law saying that the steel could not be used, and it remained there for years. The steel was made by Hussey, Wells & Co. by the crucible process in 1868.

As a representative of one of the large steel companies, J. O. Leech said:

"There seems to be considerable misapprehension about the position taken by the steel manufacturers in regard to tensile strength. All that the steel manufacturers are asking for is a reasonable working range. Less than 8000 lb. range is considerable of a hardship. We do not care where that range lies, we can make the steel any range within reason. We believe that you can obtain the very best quality of steel for boiler purposes with a tensile strength up to 68,000, or perhaps higher. Marine boilers are regularly built with a minimum of 60,000 lb. All we are asking is a reasonable working range, and we do not believe it is necessary to specify a maximum of 62,000 or 63,000 lb. to obtain the best quality of steele.

"Slight differences in chemical composition or in physical properties do not alone govern quality as now designated by the terms flange and firebox. A comparison of existing specifications will show that some have as high sulphur limits for firebox quality as others allow for flange quality. Some specifications for firebox steel have the same ranges in tensile strength that others do for flange quality, which is an indication that these properties alone do not govern quality."

Replying to a question of G. S. Barnum as to what governs the quality, Mr. Leech said that careful manufacture and inspection were chiefly responsible. He further added that phosphorus and sulphur within reason have nothing to do with the tensile strength, which is governed principally by the carbon and manganese. A piece of 68,000-lb. steel cannot be expected to show as much elongation or as much reduction of area as a piece of 60,000-lb. tensile strength, because as the tensile strength goes up, the ductility drops; but the same relative ductility will be had with 68,000 lb. tensile strength as with the 60,000 lb.

WILLIAM H. BOEHM: I do not know whether the advantage of having a narrow range is well understood. Of course, that is the whole point of the discussion, as to what is the advantage of asking the steel manufacturers to work to a narrow range, that is, a range of 8000 lb. or less. I have been led to believe that you cannot secure high tensile strength and great ductility from the same material. If you specify high tensile strength, you necessarily must have the material that is more or less brittle—a material that can be easily fractured. In boilers, a material is wanted that will stretch and not fracture; so if we specify a material of 50,000 lb., we are specifying one that we think is ductile, and we do not want it to come to us at 60,000 lb. tensile strength, because then we are going to get a material that is less ductile and is more easily fractured. That is the real reason why we want the manufacturers to work to a narrow range if they can do it.

EARNEST T. CHILD stated that the proposed new A. S. M. E. specifications would limit cast-iron boilers to 15-lb. pressure, and as representing the National Association of Steam and Hot Water Fitters, in their behalf he asked the assistance of the A. B. M. A. to obtain a modification of that recommendation with particular reference to cast-iron sectional boilers for hot-water heating. The installation of cast-iron sectional boilers for heating water is prohibited in office buildings over 35 ft. high.

WILLIAM H. BOEHM, as a member of the A. S. M. E. committee, inquired of Mr. Child whether the reason he made this request to increase the allowable working pressure on such boilers was not because some of these cast-iron boilers operate engine-driven fans, and whether in such cases he did not want a permissible pressure as high as 20 lb. per sq.in., and if so, whether he thought such pressure perfectly safe under steam and not water pressure. Mr. Child replied that he knew that a cast-iron sectional boiler was perfectly safe working on 65 lb. static pressure, as he had one in use at the present time.

Mr. Boehm insisted upon a direct answer to his question, in reply to which Mr. Child said that he did not recommend the use of cast-iron sectional boilers for high-pressure steam, such as 40 lb.

The report of the Committee on Uniform Boiler Specifications was read, as follows:

"We recommend that Sect. 8, part II, page 30, of the proposed recommendations by the A. S. M. E. be changed to read as follows:

"Safety valves having either the seat or disk of cast iron shall be allowed when riveted direct to the shell of boiler.

"Also, on same page, part II, Sect. 9, that there be inserted in the third line, after the word 'type,' the words 'or lever safety valve,' otherwise the said section to remain unchanged.

"On same page, part II, Sect. 11 be struck out and the following substituted:

"Fusible plugs, except as otherwise provided for, shall have an external diameter of not less than three-fourths of an inch pipe tap, and the banca tin shall be at least ½ in. in diameter at the smaller end, and shall have a larger diameter at the opposite end of the plug; provided, however, that all plugs used in boilers carrying a steam pressure exceeding 150 lb. may be reduced at the smaller end of the banca tin to $\frac{7}{16}$ in. in diameter.

"Fusible plugs, when used in the tubes of upright boilers, shall have an external diameter of not less than ⅜ in. pipe tap, and the banca tin shall be at least ¼ in. diameter at the smaller end and shall have a greater diameter at the opposite end of the plug.

"We further recommend, page 33, of part II, under Sect. 16, paragraph b, be changed to read as follows:

"Each boiler shall have three gage cocks, located as follows: the first gage cock to be located 2½ in. above the flue, the second gage cock to be located 4½ in. above, and the third 6½ in. above the flue.

"We further recommend that in part III, beginning at Sect. 1, all of Sect. 1 and all of the immediately following Sect. 2, down through the middle of page 186, be struck out, and that there be substituted therefor the present A. B. M. A. specifications covering materials, workmanship and dimensions, factor of safety, hydrostatic pressure and hanging or supporting the boiler.

"We further recommend that on page 208, Sect. 62 of part III, read:

"Manhole plates shall be of wrought or cast steel or cast iron."

A. B. CARHART called attention to the fact that the United States Government, while formerly calling for zinc plates in boilers on the supposition that they would prevent corrosion, had now withdrawn such specification because it had found that the zinc plates, while at first lessening corrosion, afterwards increased it, producing finally a much more intense corrosion than that which had been sought by their use to prevent. He hoped that the general public might not be misled by the action of the committee into thinking that zinc plates were unqualifiedly recommended.

At the executive session in the afternoon, the election of officers resulted in the re-election of former officers with the exception of Colonel Meier, W. C. Connelly being elected president, and in his response he pledged himself to renewed efforts for increased membership and furtherance of the objects of the association.

Among the social features of the convention were, on Tuesday evening, a reception with dancing and buffet re-

freshments, the grand promenade being led by Mr. and Mrs. George N. Riley; a sightseeing tour for the ladies, Wednesday morning; shopping and sightseeing tour to principal hotels and department stores, Thursday morning; banquet in the Astor Gallery, tendered by the Supplymen's Association, Thursday evening, and also a trip to Coney Island, with a dinner at the Hotel Shelburne, Friday.

George N. Riley was toastmaster at the banquet Thursday evening and kept the company in the best of humor. Among those who responded to toasts were the following:

Charles R. Lamb, representing the Merchants Association of the City of New York; W. C. Connelly, president-elect, A. B. M. A., Cleveland; D. J. Champion, treasurer, Supplymen's Association, Cleveland; Joseph Broderick, Muncie, Ind.; W. S. Bateman, Philadelphia, Penn.; James D. Farasey, Cleveland; Hon. Joseph Hartigan, Commissioner of Weights and Measures, New York City; Hon. G. A. Luck, chairman, Massachusetts Board of Boiler Rules; John T. Corbett, president, Supplymen's Association, Chicago; Miss A. B. Chute, Enterprise Boiler Co.

Mr. Bateman performed the pleasant duty of presenting to Mr. Champion a solid silver water pitcher.

F. B. SLOCUM, secretary of the Supplymen's Association, was presented with a solid silver service.

Decision as to place of next annual meeteing of the A. B. M. A. is at present in abeyance, awaiting the action of the Executive Committee. It is understood that the matter of holding meetings possibly more frequently than once a year has been under consideration, and plans are on foot to secure in the future a larger attendance as well as increased membership.

Central States Waterworks Association

The eighteenth annual convention of the Central States Waterworks Association was held at Wheeling, W. Va., Aug. 25 to 27. The membership of this association is composed of waterworks engineers, superintendents and others interested in water works in the states of Ohio, Indiana, Illinois, Michigan, Kentucky, West Virginia and Western Pennsylvania. The principal technical papers and discussions of the convention were centered around purification and methods of utilizing the waters of the Ohio River and this subject was of especial local interest, as the city of Wheeling has recently adopted a water supply to be taken from the Ohio River by the Smith system of supply and filtration.

FILTRATION OF OHIO RIVER WATER

In a paper presented by C. B. Cook, city engineer of Wheeling, the author stated that it is necessary for nearly every community along the Ohio River to use the water from this stream for domestic and manufacturing consumption, as there are no other adequate sources of supply available.

The Ohio River has been well called "One thousand miles of sewer," for every hamlet, village, town and city from Pittsburgh to Cairo, empty its wastes from every source into the Ohio or its immediate tributaries, without the treatment, rendering the water unfit for human, animal, or manufacturing purposes.

The discharge from some of our manufacturing plants and some of the mines along the river and its tributaries has caused great inconvenience to all users of river water for expensive renewals from the pitting of the boilers and heaters or to the use of boiler compounds.

SYSTEM IS USE

There are several methods of purification and filtration in use by the various consumers of Ohio River water: the Well System, the Crib System, the Slow Sand System, the Rapid Sand or Mechanical System and the Smith System.

DRIVEN WELLS

The casings of the wells vary in diameter as do the size and number of the perforations used. The well system generally supplies a water that is hygienically pure but the water is nearly always harder than the river water, and in some cases, wells have been known to show contamination after some years of use, as well as to show a considerable decrease in flow. In the well systems water is taken either from wells drilled in the sand and gravel bars forming the bed of the river, or from sand and gravel banks along the river, and in either case, the wells secure a large percentage of ground water. The wells are usually drilled wells with the casing driven down to or into the bed rock a short distance and the bottom of the casing drilled with holes varying in diameter from one-quarter inch to one-half inch; some of the well systems have a solid piece of casing placed at the bottom of the wells and then have a perforated pipe above this solid piece. The water is allowed to flow by gravity from the wells to a pumping station well, and then lifted by steam pumps to the consumer or is raised by compressed air lifts out of wells into a sub-basin from which it is raised by steam pumps according to local conditions.

CRIB SYSTEM

The cribs are usually built of timber, brick or concrete near the bank of the river with the water flowing in and through the sand and gravel with which the crib has been filled, the river water filtering through the sand and gravel to the intake pipe of a pumping station and from there pumped to the consumer. Mud and silt are drawn through the sand and gravel, causing the crib to become clogged and the supply to be greatly, if not wholly, cut off. The crib is usually entirely submerged so that it is not readily accessible, and so cannot be cleaned. After contamination is found to exist, the only remedy is to abandon the crib or to cofferdam it and remove the sand and gravel. This is usually an expensive process, generally requiring the consumer during the execution of the work to use the raw river water and this clogs the distributing mains.

THE SLOW SAND SYSTEM

This is sometimes called the English system, as built in various parts of the country, and consists of filter units having an area ranging from one-half to one acre, the filter proper being contained in water-tight tanks, the walls and floors of which are constructed of concrete or brick. At the bottom of the filter tank is located the underdraining system, which takes the form of channels over which are laid large stones or boulders and then layers of graded gravel diminishing in size of particles toward the top. On top of these layers of underdraining material is the filter bed itself, which is composed of some three or four feet of carefully selected washed sand.

The filter is operated by allowing the raw water to flow on to the surface of the filter so that there is always a volume of water three or four feet deep when the filter is in operation. The discharge of slow sand filters does not at any time exceed about three million gallons per acre of filter surface per day. The mud, silt, clay and bacteria accumulating on the surface of the filter as it operates, increase in density and thickness until the filter refuses to pass the requisite amount of water. It then becomes necessary to shut down the filter, drain it and scrape off an inch or so of clogged material, following which operation the filter is refilled, the inlet and outlet opened and operation is resumed.

RAPID SAND OR MECHANICAL PROCESS OF FILTRATION

This system uses first a coagulating basin which is usually built of concrete, into which is pumped the raw water and into the raw water the coagulating chemicals are placed. The chemicals usually employed are sulphate of alumina and sulphate of iron, and sometimes lime applied to the raw water by various mechanical devices. The coagulating basin is built in two ways; first, a plain basin, and second by adding baffle walls inside the basin to retard the flow of the water through the basin, giving a longer period of sedimentation. If a plain basin is used, it should have a capacity of several days' flow; if the basin be baffled the capacity may be reduced to from eighteen to twenty-four hours' flow.

The coagulating chemicals form a glutinous substance to which the heavier particles in the raw water adhere and are precipitated to the bottom of the settling basin, from which they are drawn off into a drain. The water thus prepared then passes on through the filter beds which are usually built of concrete in units of from three to four million gallons capacity. At the bottom of the beds is located the underdraining system which takes the form of channels over which are placed layers of graded gravel diminishing in size toward the top. On top of this underdraining material is placed the filter bed of carefully selected washed sand. The water passes down through these filter beds at a rate of one hundred and twenty-five million gallons per acre of filter surface per day into a clear water basin and from this basin into the distributing system.

When these beds have become clogged with the materials in the water that have not been removed by sedimentation in the coagulating basins, the water is drawn off through the sewer and the clear filtered water is forced up and through the beds, stirring the gravel and sand, thoroughly washing it and the dirty wash water passes off into the sewer and the unit is again placed in commission. Compressed air is sometimes forced up through the washing water to agitate the sand for more thorough operation of the washing process.

THE SMITH SYSTEM

In this system strainer pipes are placed below a filtering bed in the river. The system is not applicable to all locations, but must have the natural facilities in the form of a proper gravel and sand bed in the river.

ADAPTABILITY AND EFFICIENCY

All the systems of filtration in use along the Ohio River have their strong adherents and their opponents. No system has a general adaptability, but each locality presents its individual problem, and these problems must be met by the most careful scientific study so that they may be solved in an economical, hygienic and conclusive manner. Because a system of filtration may be appropriate to one locality is no reason why it will suit another. None of the systems are fool-proof but must be operated with care. To guard against imperfect operation the filtered water should be examined at regular and at frequent intervals for the raw water changes its character from long periods of draught to times of freshet and at times changes occur very suddenly.

In a well system where the water passes from the wells to the well at the pumping station, where the water ends of pumps are submerged, the analyses frequently show high counts of bacteria and frequently show coli. It is quite possible that the raw water is leaking into the pump well contaminating the water taken from the filter well. It is also true that where a rapid sand or mechanical filter is in use there are frequent complaints of disagreeable taste and odor in the water and others have the red water plague, and give trouble from clogging of pipes connected with plumbing fixtures all of which result from bad design or neglect in the handling of the plant, and are entirely preventable.

DISCUSSION

In discussion of the paper, Dr. S. L. Jepson, secretary of West Virginia State Board of Health, stated as the result of his investigations covering some years, that the mechanical filtration system was the best available for Ohio River water, in which conclusion he believed that hydraulic engineers of reputation not only in this country but in Europe would coincide. He characterized as a "monumental blunder" the action of the city council of Wheeling in asking the people generally to express their preference by straw vote as to what system of filtration should be adopted; this he considered a matter properly of scientific determination only, and a matter about which laymen cannot expect to know, and even the best informed know none too well. He stated that eight years ago the Government officials had condemned all plans of natural sand filtration for Wheeling.

J. C. Martin, president of the association, spoke at some length upon the general question of the importance of filtration and cautioned the citizens of Wheeling that it would be well to go slow before launching into an investment which would no doubt represent as large an indebtedness as they could carry comfortably for some time to come. Before entering into such an expenditure it would be well to carefully consider and be guided, not by uninformed opinion or bias but to follow the recommendations of scientifically trained experts who had made these matters a life-time study. While he did not wish to take any sides in a local controversy, he believed that it would be unwise to adopt any plant the mechanism of which would be concealed in the bed of the river and its operation not susceptible of frequent examinations from time to time as occasion might arise to find if it was in good order, and whether it was doing the work it was intended to do, which inspection could not be made without uncovering the bed of the river at great and almost prohibitive expense.

SMITH SYSTEM AT PARKERSBURG, W. VA.

L. E. Smith, patentee of the Smith system, in a paper on "Filtration and Purification of Ohio River Water" described the system devised by the author. It consists of laying horizontal strainer pipes five or six feet below the bed of the river and connecting a gravity line to the intake at the pumping station, so the water may flow by gravity to the pumps. In the plant now in operation at Parkersburg, W. Va., the beds comprise five units, each unit consisting of two parts, the parts and units being separated 25 ft. by unexcavated parts of sand bar about 450 ft. from the West Virginia shore of the Ohio River. An 18-in. gravity line leads from each of the units to a valve chamber on the shore, the effluent entering a manifold, to which is attached the pipe leading to the pumps.

The guaranteed capacity of the plant is 4,000,000 gal. daily. There are 160 strainers, 5 in. in diameter by 15 ft. long, each containing 9400 slots. The strainers are placed in an excavation 5½ ft. deep, covered with coarse screened gravel to a depth of 15 in., and over this bed is a layer of fine gravel. Water passes down through the bed of sand at the rate of about 5 in. per hour. Provision is made for backflushing by which any unit may be separately backflushed of pollution without interfering with the regular operation and use of the remaining units.

During the discussion of the paper the author stated he believed the system to be the best possible where conditions were favorable; there must be a suitable bed of gravel to insure purification and clarification of the water.

The Public Hearing of the Boiler Specifications Committee

The work of the Boiler Specifications Committee marks one of the most important undertakings of the American Society of Mechanical Engineers.

During the past few years, the introduction of boiler inspection laws in various states and cities has aroused the necessity for the establishment of uniform requirements, and the efforts of the committee in this direction have been generally favored and supported. It has been found that the most important interests are in favor of the best material and construction known, and the letters that have been received, particularly from those abroad, quite generally indorse the position that has been taken by the committee.

The basic idea of the committee's work is the formulation of a standard of the highest requirements, thereby reducing the great loss of life and property in the United States from boiler explosions and derangements, which are for the most part preventable. It is the intention also to create a standard which, it is hoped, will ultimately be adopted by the Federal Government and state governments not now having boiler regulations, and, through uniform legislation, to produce such a condition of affairs that a boiler built for any one state will be acceptable in any other.

Where state legislation has been enacted, it is hoped that it will be modified to conform to the society's model.

The preliminary work of the Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for the Care of Same in Service, which was completed last February and placed in the form of a tentative report, was issued in an edition of 1500 for a preliminary study, and was submitted to recognized authorities throughout the civilized world, including nonmembers of the society as well as members; it was sent to boiler manufacturers, prominent steel manufacturers, insurance companies, boiler users, consulting engineers, operating engineers, and all who are known to have special knowledge of the boiler business. With each copy was sent a request that the recipient should take out whatever was considered inadvisable and add whatever would further safeguard human life and property.

At the St. Paul-Minneapolis meeting, much interest was shown in the work of the committee. This was not considered as a report, but a topical discussion of some of the more important phases of steam boiler legislation was held, and many of the points in boiler practice on which there is a difference of opinion were considered. There had been a conference at Chicago, on Monday, June 15, between representatives of the committee, the Association of Steel Manufacturers and the National Tubular Boiler Manufacturers Association, at which the discussion was devoted largely to the steel specifications desired. This discussion was continued at the opening session of the spring meeting on Wednesday morning, June 17, and was transferred later to a separate meeting room, where it was continued the greater part of the day. The committee has sought in every way to secure the most full expression of opinion. The necessity for a careful study of the more important factors involved was emphasized by the committee, and the result of the discussion was a resolution calling for a public hearing in New York in September, as follows:

Resolved, that on Sept. 15, 1914, the committee hold, in the rooms of the American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y., a hearing of all interests concerned on the preliminary report of the committee appointed to formulate standard specifications for the construction of steam boilers and other pressure vessels and for the care of same in service, and that those desiring to participate in the discussion present their criticisms and suggestions in writing prior to Aug. 15.

Resolved, that in addition to invitations, notification by publication in the technical press be given to the hearing.

Carrying out the policy of the committee and the society in all of its determinations, invitations have been sent out to the following associations and engineering organizations known to be interested in the matter of standard boiler specifications:

American Boiler Manufacturers Association,
American Institute of Steam Boiler Inspectors,
American Railway Master Mechanics Association,
American Society of Heating and Ventilating Engineers,
American Society of Testing Materials,
Association of American Steel Manufacturers,
City of Chicago, Department of Boiler Inspection,
City of Detroit, Office of Chief Boiler Inspector,
City of New York, Department of Boiler Inspection,
City of Philadelphia, Department of Boiler Inspection,
Committee on Relation of Railway Operation to Legislation,
Indiana State Bureau of Boiler Inspection,
Industrial Commission of Wisconsin,
Interstate Commerce Commission,
Marine Engineers Beneficial Association,
Massachusetts Public Service Commission,
Massachusetts Board of Boiler Rules,
Montana State Board of Boiler Inspection,
National Association of Boiler Manufacturers
National Association of Cotton Manufacturers,
National Association of Stationary Engineers,
National Association of Thresher Manufacturers,
National Bureau of Standards,
National Council for Industrial Safety,
National Tubular Boilermakers Association,
New York State Commission on Uniform State Laws,
Ohio State Board of Boiler Rules,
Public Service Commission, Second District, New York State,
State of Illinois,
State of Maryland,
State of New York,
State of North Carolina,
State of Pennsylvania, Department of Labor and Industry,
State of Virginia,
U. S. Board of Supervising Inspectors of Steam Vessels,
U. S. Bureau of Steam Engineering,
U. S. Department of Commerce.

Most of the organizations named have accepted the invitation.

These organizations were invited to be present or to have representation at the hearing, which will be held in the rooms of the society, in New York, at 10 a.m., Tuesday, Sept. 15, and also, in so far as possible, that all who had not already done so, prepare and send a statement in writing previous to the hearing, to assist in the deliberations.

The foundation of these rules is the boiler law of Massachusetts, which has been enforced for some time and which has recently been adopted by the state of Ohio, the city of Detroit and the city of Manila, in the Philippine Islands. Several of the other states are now considering the adoption of standard rules regulating boilers and other pressure vessels. In the six years that the Massachusetts rules have been in force, over 8300 boilers have been constructed to that standard, and boiler explosions and derangements have been reduced to a minimum.

Much credit is due to the committee for its tireless efforts in preparing the tentative report, in collating the enormous amount of data embodied in the voluminous recommendations on which the tentative draft was based. The work has involved much self-sacrifice on the part of the members, particularly John A. Stevens, chairman, whose extensive experience as a member of the Board of Boiler Rules of the State of Massachusetts, in developing and inaugurating the Massachusetts standard, has been turned to advantage in the work here undertaken. The other members of the committee to whom much credit is also given are W. H. Boehm, R. C. Carpenter, Richard Hammond, C. L. Huston, E. D. Meier and E. F. Miller. This work, which is borne exclusively by the committee members and by the American Society of Mechanical Engineers, is for the benefit of the people through the protection of life and property and of the boiler industry at large. It is national in character and its effect will be felt not only by the manufacturing interests in easier conditions for selling, but also will be of similar benefit to the users, as it will enable them to secure boilers more promptly and at less cost for a safe boiler.

PERSONALS

Henry D. Shute has been elected treasurer of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., to succeeed T. W. Siemon, who recently resigned to accept the position of secretary-treasurer of the Union Switch & Signal Co., Swissvale, Penn.

Mr. Shute was born at Somerville, Mass., and is a graduate of the Massachusetts Institute of Technology. He has been with the Westinghouse electric company since 1893, first in the testing department, then in erecting and laboratory work, and in the engineering department until 1898, when he was transferred to the commercial department. In 1903 he was made assistant to Vice-President L. A. Osborne, in which position he was particularly active in developing the heavy electric traction and single-phase railway work. In 1910 he succeeded Walter McFarland as acting vice-president of the company.

Mr. Shute is a member of the American Institute of Electrical Engineers, National Electric Light Association, Engineers Club of New York, is a director of the Pittsburgh Chamber of Commerce, and is closely identified with a number of other technical and social organizations.

Truman P. Gaylord, district manager of the Westinghouse Electric & Manufacturing Co. at Chicago, has been elected acting vice-president to succeed H. D. Shute, now secretary-treasurer. Mr. Gaylord was born at Shelby, Mich., and graduated from the Armour Institute of Technology.

He was engineer of underground construction during the World's Fair at Chicago, 1892-3. Then he became assistant professor of electrical engineering in the Armour Institute until 1898, when he became electrical engineer for the Commonwealth Edison Co. of Chicago.

From 1899 to 1902 he was a salesman for the Westinghouse Electric & Manufacturing Co. Then he was made district manager of the company in Chicago.

Mr. Gaylord is a member of the American Institute of Electrical Engineers, the National Electric Light Association, and is closely identified with a number of other engineering societies.

NEW EQUIPMENT

ATLANTIC COAST STATES

Fire recently destroyed the electric-light plant at Mount Vernon, Maine, owned by R. H. Jacobs. Loss, $10,000.

The Central Maine Power Co., Waterville, Maine, plans to build a new fireproof station to replace the one recently burned. F. H. Mason is Ch. Engr.

Bids will be received by Dr. Carl J. Hedin, Supt. of Maine School for Feeble-Minded, West Pownal, Maine, until noon, Sept. 18, for constructing a power plant and transmission line. Arthur B. Fels, 60 Union St., Portland, is Engr.-in-Charge.

Bids will be received until 2 p.m., Sept. 28, by E. L. Williams, Cornell University, Ithaca, N. Y., for the construction, heating and plumbing and electric work for the new drill hall for Cornell University.

The Atlantic City Electric Co., Atlantic City, N. J., has secured a permit and will soon call for bids for the construction of a power house costing about $9000.

Fire recently damaged the power station of the Philadelphia Electric Co., Robbins Ave., Philadelphia, Penn. Loss, $10,000.

WEST OF THE MISSISSIPPI

Fire, Aug. 24, destroyed the Adel Light & Power plant, Adel, Iowa. The estimated loss is $50,000.

At a recent election, the citizens of Aurelia, Iowa, voted in favor of a bon dissue for the construction of a municipal electric-light plant. The estimated cost is $7000.

Press reports state that the Town Council, Aurora, Minn., cotemplates erecting a municipal electric-light plant.

A municipal electric-light plant, costing $10,000, will be constructed at South Sioux City, Iowa (Sioux City post office).

Bids will be received by the State Board of Control, St. Paul, Minn., until noon, Sept. 15, for power-plant equipment for the St. Cloud State Reformatory, St. Cloud, Minn. The Charles L. Pillsbury Co., Metropolitan Life Bldg., Minneapolis, Minn., is Engr.-in-Charge.

The citizens of Kansas City, Kan., at a recent election, voted to issue $450,000 in bonds, the proceeds to be used for making improvements to the municipal electric-light plant. The following equipment is needed: Boilers, a 3000-kw. turbine, coal and ash-handling machinery, superheaters, steam and water piping. The estimated cost is $200,000.

The City Council, De Witt, Neb., is considering plans for the establishment of a municipal electric-light plant to cost $15,000.

The Wild Cat Mining Co., White Oaks, N. M., contemplates building an electric power plant and a power transmission line to its mines in Nogal Cañon and to Carrizozo. A. B. Graham, J. H. Fulmer, Jr., and W. H. Tupper, all of Mishawaka, Ind., are interested.

The Auburn Gas Co., Auburn, Wash., will construct a gas plant, estimated to cost $40,000. J. L. Veach is Mgr.

On Aug. 29, fire destroyed the power plant of the Northern California Power Co., Redding, Calif. The town is without light or power. Loss about $20,000.

The Mount Whitney Power Co., Tulare, Calif., will build a reinforced-concrete substation. H. A. Kluegel, Visalia, Calif., is Ch. Engr.